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NOAA Technical Memorandum NESS 88

NATIONAL ENVIRONMENTAL SATELLITE SERVICE CATALOG OF PRODUCTS

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NESS 63 Snow Depth and Snow Extent Using VHRR Data From the NOAA-2 Satellite. David F. McGinnis, Jr., John A. Pritchard, and Donald R. Wiesnet, February 1975, 10 pp. (COM-75-10482/AS)

(Continued on inside back cover)

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NATIONAL ENVIRONMENTAL SATELLITE SERVICE CATALOG OF PRODUCTS

Dennis C. Dismachek, Editor

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ATMOSPHERIC ADMINISTRATION
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National Environmental
Satellite Service
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CONTENTS

Acronyms, abbreviations, and terms viii

Abstract 1

Introduction 1

A. Background 1
B. Data sources 3
C. Using the satellite products catalog 8
D. Data availability 9

I. Image products 10

A. Geostationary satellites 10

1. Photographic imagery 10

a. Full-disk and sector displays 10
b. Direct readout and GOES-Tap 14
c. Movie loops 15
d. U.S. cloud cover depiction 17

2. Facsimile 19

a. SMS/GOES facsimile displays transmitted on standard FAX circuits 19
b. SMS/GOES WEFAX 21
c. ATS WEFAX 24

B. Polar-orbiting satellites 27

1. Photographic imagery (computer derived) 27

a. Stretched, gridded pass-by-pass SR images 27
b. SR hemispheric polar-stereographic mosaics 31
c. SR polar-stereographic quadrant mosaics 36
d. SR Mercator mosaics 38
e. Very High Resolution Radiometer (VHRR) basic images 41
f. Ten-day minimum composite brightness 44

2. ITOS/NOAA facsimile displays 46

3. NOAA direct readout..... 49

II. Meteorological services..... 51

A. Satellite winds: low-, middle-, and high-level cloud motion vector field messages..... 51

B. Atmospheric soundings: Vertical Temperature Profile Radiometer (VTPR) soundings..... 54

C. Weather summary and bulletins..... 56

1. Satellite interpretation message..... 56
2. Satellite weather bulletin..... 58
3. Tropical disturbance summary..... 60

D. NMC support..... 62

1. Two-layer moisture analysis..... 62
2. Satellite Input to Numerical Analysis and Prediction (SINAP)..... 64

E. Miscellaneous..... 66

1. Briefings and advisory support..... 66
2. Training aids..... 67
3. Automatic picture transmission information note.... 68

III. Oceanographic services..... 69

A. Sea Surface Temperature (SST) products..... 69

1. Global operational SST observations..... 69
2. Great Lakes surface temperature analysis..... 73

B. Ice charts and ocean current analyses..... 75

1. Great Lakes and Alaskan ice charts..... 75
2. Gulf Stream Wall bulletin and experimental Gulf Stream analysis..... 78
3. West coast thermal front analysis..... 81

IV. Hydrological services..... 83

A. Basin snow cover observations..... 83
B. Northern Hemispheric snow and ice chart..... 88

V. Astrogeophysical services: Astrogeophysical Teletype Network (ATN) messages..... 90

Acknowledgments..... 97

References..... 98

FIGURES

1. Approximate viewing and receiving area of SMS/GOES.... 4

2. Satellite data dissemination chart..... 6

3. Example of enhanced infrared photographic display..... 11

4. Example of a full-disk photographic image (ungridded)..... 12

5. Example of the U.S. cloud cover depiction--photographic display, surface analysis, and narrative description..... 18

6. Examples of gridded and unrectified facsimile displays of SMS/GOES VISSR data..... 20

7. Example of SMS/GOES WEFAX mapped SR image..... 22

8. Example of SMS/GOES WEFAX unrectified VISSR image..... 23

9. Example of ATS WEFAX mapped Mercator SR image..... 25

10. Example of ATS WEFAX mapped polar-stereographic SR image..... 26

11. Example of stretched-gridded and unrectified pass-by-pass SR image..... 29

12. Tracks of polar-orbiting satellite's subsatellite point..... 30

13. Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, visible data)..... 33

14. Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, infrared daytime data)..... 34

15. Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, infrared nighttime data)..... 35

16. Example of four SR polar-stereographic quadrant mosaics..... 37

17. Example of SR Mercator mosaic (visible data)..... 39

18. Example of SR Mercator mosaic (infrared nighttime data)..... 40

19. Example of Very High Resolution Radiometer (VHRR) basic image..... 43

20. Example of 10-day minimum composite brightness display..... 45

21. Example of SR mapped polar-stereographic facsimile display..... 47

22. Example of SR mapped Mercator facsimile display..... 48

23. Example of Very High Resolution Radiometer (VHRR) image received via direct readout in Scotland, United Kingdom..... 50

24. Example of a coded low-, middle-, and high-level cloud-motion vector field message (top) and a description of the code format (bottom)..... 53

25. Approximate locations of VTPR soundings..... 55

26. Example of Satellite Interpretation Message..... 57

27. Example of Satellite Weather Bulletin..... 59

28. Example of Satellite Tropical Disturbance Summary..... 61

29. Example of a two-layer moisture analysis..... 63

30. Example of Satellite Input to Numerical Analysis and Prediction (SINAP) chart..... 65

31. Example of GOSSTCOMP "quick look" photographic display of sea surface temperatures and spatial distribution of observations..... 71

32. Example of GOSSTCOMP gridded analysis of sea surface temperatures..... 72

33. Example of Great Lakes surface temperature analysis of Lake Huron..... 74

34. Example of Great Lakes ice chart..... 76

35. Example of Alaskan ice chart..... 77

36. Example of Gulf Stream Wall bulletin..... 79

37. Example of experimental Gulf Stream analysis..... 80

38. Example of West Coast thermal front analysis..... 82

39. Example of a percentage snow-cover message and a mapped snow-covered basin for the Salt-Verde Watershed in Arizona. Snow-covered areas are in black (35)..... 84

40. Example of Northern Hemisphere snow and ice chart..... 89

41. Example of Astrogeophysical Teletype Network (ATN) message..... 91

TABLES

1. Movie loops available as of August 27, 1976..... 16

2. Current basins for operational snow mapping as of June 1, 1976..... 85

3. Product summary..... 93

ACRONYMS, ABBREVIATIONS, AND TERMS

APT	Automatic Picture Transmission
ATN	Astrogeophysical Teletype Network
ATS	Applications Technology Satellite
BPI	Bytes per inch
CDA	Command and Data Acquisition (Station)
CRT	Cathode Ray Tube
DAPS	Data Acquisition and Processing System
DDHF	Digital Data Handling Facility
DMD	Digital Muirhead Display
DSB	Direct Sounding Broadcast
EDS	Environmental Data Service
ERL	Environmental Research Laboratory
FAA	Federal Aviation Administration
FOFAX	Forecast Office Facsimile Network
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GOSSTCOMP	Global Operational Sea Surface Temperature Computation
Gridding	Implanting of latitude/longitude grid lines and geographic boundaries into imagery
HRPT	High Resolution Picture Transmission
IR	Infrared
IR enh	Infrared enhanced
ITCZ	Intertropical Convergence Zone
ITOS	Improved TIROS Operational Satellite
km	Kilometer
LST	Local Standard Time
M	Million
Mapped	Treatment of imagery to include both gridding and rectification
mb	Millibar
MMIPS	Man/Machine Interactive Processing System
MRH	Mean Relative Humidity
NAFAX	National Facsimile Network
NAMFAX	National Meteorological Facsimile Network
NCC	National Climatic Center
NESS	National Environmental Satellite Service
NMC	National Meteorological Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NTIS	National Technical Information Service
NWP	Numerical Weather Prediction
NWS	National Weather Service
PE	Primitive Equation
PIREP	Pilot Report

QPF	Quantitative Precipitation Forecasts
RAOB	Radiosonde Observation
RDO	River District Office
Rectification	Transposition of data points in a field of imagery from raw position to reflect a particular map projection, i.e., polar-stereographic or Mercator
RFC	River Forecast Center
SDSB	Satellite Data Services Branch
SEM	Space Environmental Monitor
SFO	San Francisco
SFSS	Satellite Field Service Station
SINAP	Satellite Input to Numerical Analysis and Prediction
SMS	Synchronous Meteorological Satellite
SPM	Solar Proton Monitor
SR	Scanning Radiometer
SRIR	Scanning Radiometer Infrared
SRVIS	Scanning Radiometer Visible
SST	Sea Surface Temperature
TOS	TIROS Operational Satellite
USN	United States Navy
VHRR	Very High Resolution Radiometer
VIS	Visible
VISSR	Visible Infrared Spin Scan Radiometer
VREC	Very High Resolution Radiometer Data Recorded
VTPR	Vertical Temperature Profile Radiometer
WEFAX	Weather Facsimile Network
WMO	World Meteorological Organization
WWB	World Weather Building
Z	Greenwich Mean Time

NOAA TECHNICAL MEMORANDUM NESS 88
NATIONAL ENVIRONMENTAL SATELLITE SERVICE
CATALOG OF PRODUCTS

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National Environmental Satellite Service, NOAA
Washington, D.C.

ABSTRACT. This volume of NOAA Environmental Monitoring and Prediction Products and Services has been compiled to provide users with a description of all the currently available operational products of the National Environmental Satellite Service (NESS). It is also an update to the Catalog of Operational Satellite Products (1974). A product is defined as any item routinely produced and available for applications within the environmental sciences. These range from photographic displays, charts, and teletype messages to the raw alphanumeric data available on computer disk and tape. A brief description of the product, its known accuracies (when applicable), a list of primary users, and an example of the product are given; a summary table of products can be found at the end of this chapter for quick reference.

INTRODUCTION

A. Background

When TIROS-1 was launched in 1960, the first satellite "products" of interest to environmentalists were the basic cloud pictures. Soon thereafter derived products took the form of analyses of significant weather, and before long nephanalyses for limited areas were being produced routinely. With a change in camera mounting on TIROS-9, the first view of the entire global cloud structure was obtained. The TIROS Operational Satellite (TOS) series commenced in the mid-1960's with the launch of ESSA-1, and, with growing assistance from computers, the product line began to diversify.

Aside from documents describing the growing cloud picture archive (Key to Meteorological Records Documentation), need for a products catalog was evident, and in 1968 limited samples of a draft document were circulated for comment. Although a technical report (Leese et al. 1970) described the climatological aspects of data in satellite images, it soon was outdated as the

operational product line continued to change. Experiments with spin/scan image data from NASA's geostationary Applications Technology Satellites (ATS) led to routine extraction of cloud motion wind estimates (Young et al. 1972) during the summer of 1969. Soon thereafter, the Improved TIROS Operational Satellite (ITOS) system provided sensors for indirect soundings (McMillin et al. 1973), as well as infrared scanners for thermal target sensing (Leese et al. 1971) and for nighttime imaging (Conlan 1973).

The early 1970's saw the advent of the Synchronous Meteorological Satellite (SMS) and the Geostationary Operational Environmental Satellite (GOES) series, continually viewing the Western Hemisphere from a height of some 35,000 km above the earth's equator (Burr and Pipkin(1973).

With the continued growth in the number of products derived from raw data obtained from the geostationary and polar-orbiting satellites, the catalog of operational products has become an increasingly useful aid to the user community. The products described herein are any items routinely produced and available for application within the environmental sciences. These range from photographic displays, charts, and teletype messages, to the raw data available on computer disk and tape. This catalog is an update to the Catalog of Operational Satellite Products (Hoppe and Ruiz 1974) and has been designed to be easily updated as new products become available and old products are improved or replaced.

This catalog contains a brief description of each product. An effort to reveal the accuracy of each product, when applicable, has been made. Also, a list of primary users is included to point out the lines of product dissemination. Examples of each product are included with the description, whenever possible. Table 3, a summary table of products, can be found at the end of this chapter for quick reference.

B. Data Sources

The spacecraft and sensor components have been described in detail elsewhere (Fortuna and Hambrick 1974, Burr and Pipkin(1973), but a brief review here may enable readers to better assess the potential applicability of the data to their missions.

The geostationary satellites of the SMS/GOES series are equipped with a Visible and Infrared Spin Scan Radiometer (VISSR), Space Environmental Monitor (SEM), and data-relaying capabilities. These satellites are in a geosynchronous orbit at an approximate altitude of 35,800 km over the equator, viewing the Western Hemisphere as shown in figure 1.

The VISSR sensor scans the full disk of the earth in 18.2 min (Ludwig 1975), viewing in the visible spectrum (0.55 to 0.75 μm), and in the infrared window region (10.5 to 12.6 μm). Visible data resolution is approximately 1 km and infrared data resolution is approximately 8 km at the satellite subpoint.

The SEM sensors continuously monitor solar activity by measuring the flux of energetic particles, solar X-rays, and magnetic fields. These data are used for environmental research and in alerting ground communication systems of imminent solar storm activity.

The satellite communication system provides for the transmission of VISSR, SEM, and local environment monitor data to primary receiving sites and also is used for the retransmission of Weather Facsimile (WEFAX) data to local users.

Polar-orbiting satellites of the ITOS/National Oceanic and Atmospheric Administration (NOAA) series are launched into near 1,450-km sun-synchronous (quasi-polar) orbits with equator crossings near 9:00 A.M. (descending node[1]) and 9:00 P.M. (ascending node) local sun time. The spacecraft is gyroscopically stabilized with momentum stored in a large flywheel. The box is maintained in a constant earth-pointing attitude by means of a closed-loop pitch-detecting and -correcting system and by roll and yaw magnetic torquing command from the ground. Sensors on board include the Scanning Radiometer (SR), Very High Resolution Radiometer (VHRR), Vertical Temperature Profile Radiometer (VTPR), and the Solar Proton Monitor (SPM). Data are relayed to the ground through VHF and S-band frequencies.

---

[1]A spacecraft crossing the equator from north to south is on the descending part of the orbit, while a south-to-north crossing is called the ascending node.

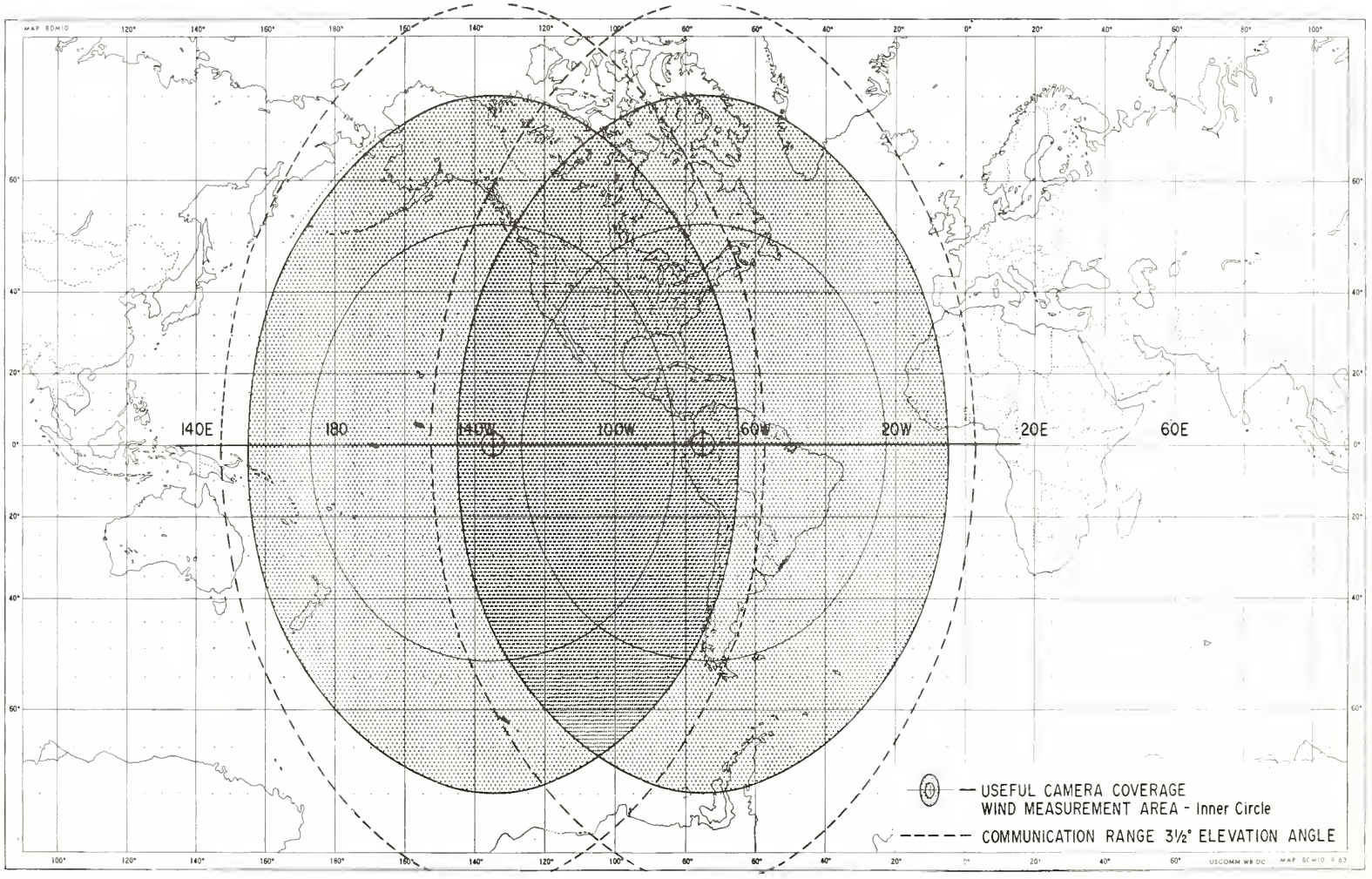


Figure 1.--Approximate viewing and receiving area of SMS/GOES.

The SR sensor is a two-channel (0.5- to 1.0-μm visual channel and 10.5- to 12.5-μm infrared channel) imaging device that continuously scans in a horizon-to-horizon crosstrack mode with scan steps provided by the forward motion of the spacecraft. Visible data resolution is approximately 4 km and infrared data resolution is approximately 8 km at the satellite subpoint.

The VHRR sensor detects energy in the visible spectrum (0.6 to 0.7 μm) and infrared window region (10.5 to 12.5 μm) with a scanning system similar to the SR sensor described previously. Visible and infrared resolutions are approximately 0.8 km at the satellite subpoint.

The VTPR sensor obtains data from which the vertical temperature structure of the atmosphere can be inferred by viewing in eight separate spectral channels--six in the 15-μm CO_2 region, one in the 11.8-μm window, and one in the 18.7-μm water vapor region. When these data are combined, temperature profiles and total water vapor content of the atmosphere can be obtained from the surface to 30 km.

The SPM sensor measures the flux of energetic particles (protons, electrons, and alpha particles) towards the earth along the local vertical and to the side of the spacecraft away from the sun along the orbital normal. These data, like those obtained from the SEM, are used in forecasting and warning of solar storm activity and in environmental research.

Data-relaying systems of the polar-orbiting satellites provide raw data readout of SR, VHRR, VTPR, and SPM data to ground receiving stations around the world having Automatic Picture Transmission (APT) and modified S-band High Resolution Picture Transmission (HRPT) receiving equipment.

The data relaying and dissemination that are currently operational involve data observed by the SMS/GOES and ITOS/NOAA series of satellites, data transmitted as direct readout by the same, and data that are received and transmitted by the National Environmental Satellite Service (NESS) Data Acquisition and Processing System (DAPS) through the SMS/GOES and ATS. This dissemination system is depicted in figure 2.

All sensor data for central processing are acquired by the two NESS Command and Data Acquisition (CDA) stations at Gilmore Creek, Alaska, and Wallops Island, Va. Raw data signals arrive at Suitland, Md., via microwave link and enter a specialized Digital Data

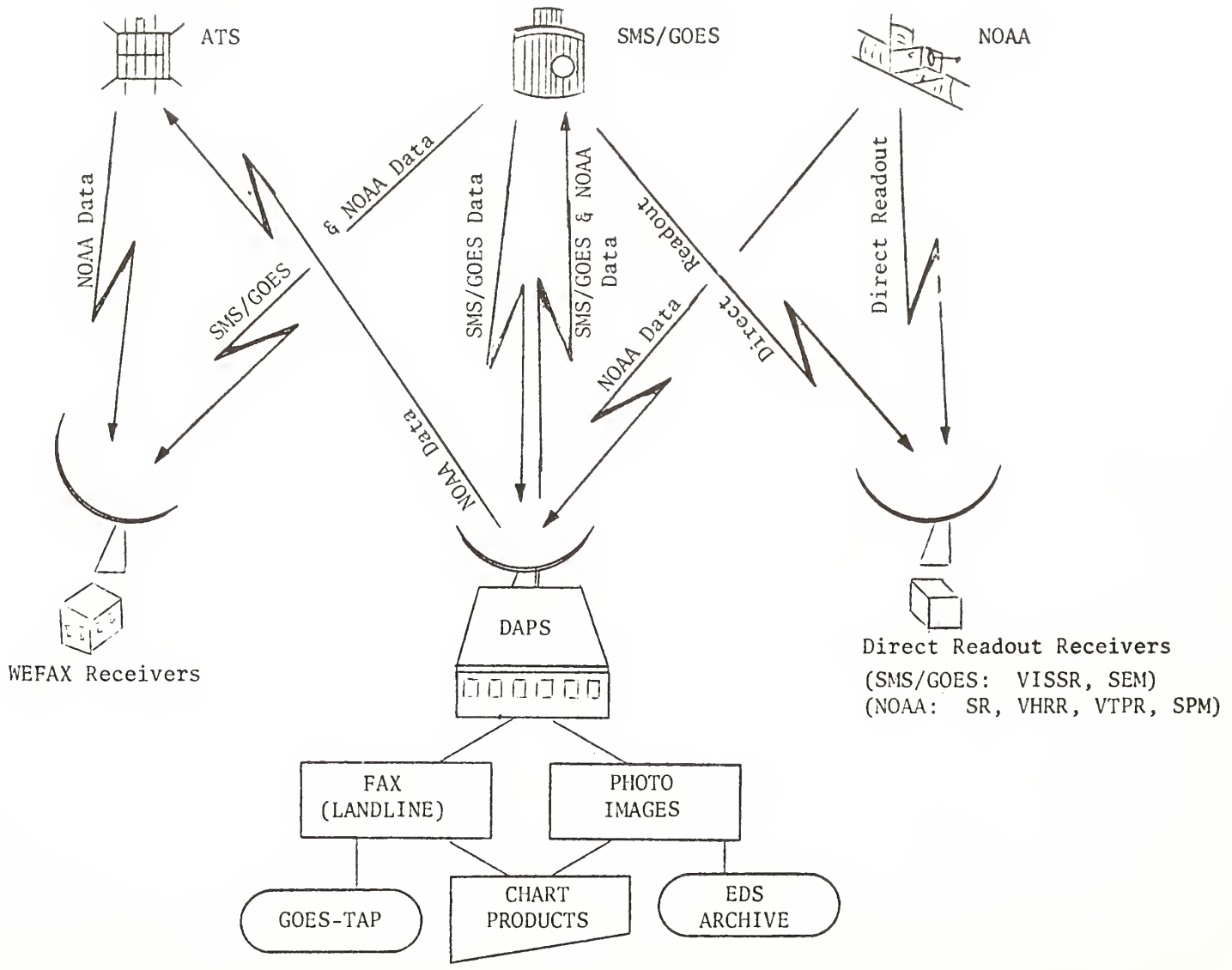


Figure 2.--Satellite data dissemination chart.

Handling Facility (DDHF) (Kahwajy 1970). Dedicated medium-scale computers within the facility are used to perform certain preprocessing tasks and to arrange the data for further treatment (Bristor 1971), by means of either manual analysis or large-scale computer.

The data stream arriving at Suitland, Md., is recorded on a photofacsimile recorder, on digital magnetic tape, or on both (Doolittle et al. 1970). Again, the data are available for further manual treatment or as input for large-scale computer processing. Photographic imagery products are not available until at least 1 1/2 h after receipt of signal at NESS. Photofacsimile recording time and photo lab processing time of about 45 min each account for this delay. In addition to these processing delays, certain photo products by their nature (e.g., end-of-day mosaics, multiday composites) contribute to the delay.

C. Using the Satellite Products Catalog

This catalog has been constructed in a form that is clear, concise, and easily referenced. All products described are listed with their title, description, accuracy (when applicable), and primary users. An effort has been made to present an example of each product and any tables that might help to inform the user of what is available or where one might obtain data. Table 3 at the end of this chapter is a product summary table for quick reference. For any information on archived products, contact

Satellite Data Service Branch (SDSB)
World Weather Building, Room 606
Camp Springs, Md. 20233

The acronyms and abbreviations used in this catalog are listed in a table following Contents.

D. Data Availability

NESS satellite data products may be requested as follows:

Real-time products--By prior arrangement with NESS after which the product is produced routinely on a standing order in real time or in delayed time before the operational master (film, tape, or hard copy) has been archived. For these products, users supply their own communication links and pick up the product or arrange to have it mailed.

Requests for real-time products should be addressed to

National Environmental Satellite Service (NESS)
Director of Operations, FB-4
Washington, D.C. 20233

Retrospective products--These are produced from operational masters that require search of the archives at the SDSB of the National Climatic Center (NCC), retrieval, preparation of copies, and refile of the master.

Requests for retrospective data products should be addressed to

Satellite Data Services Branch, NCC
World Weather Building, Room 606
Washington, D.C. 20233

Both NESS and the Environmental Data Service (EDS) operate under a user charge and service policy that requires the recovery of the cost of reproduction of satellite data products. The required charge will be specified during the initial arrangements for receipt of the data. Direct billing for these products is handled through NCC.

I. IMAGE PRODUCTS

A. Geostationary Satellites

1. Photographic Imagery

a. Full-Disk and Sector Displays.

Description. The Field Services Division of NESS regularly distributes satellite photographic displays to the National Weather Service (NWS) offices and various other users. The data used to make these displays are obtained from the Visible Infrared Spin Scan Radiometer (VISSR) sensors on board the Synchronous Meteorological Satellite (SMS)/Geostationary Operational Environmental Satellite (GOES) series of satellites. These sensors continually view the regions shown in figure 1. Eight visible channels in the range 0.55 to 0.75 μm and two infrared channels in the 10.5- to 12.6-μm wavelength region are viewed as the VISSR sensor scans across the earth (Bristor 1975). For a description of the "enhanced" infrared (IR) data (figure 3) that are available, see the Field Service Division "GOES/SMS User's Guide."

Two complete full-disk data sets (one for the geostationary satellite over the subpoint 0.0° N. latitude, 135° W. longitude; the other for the subpoint 0.0° N. latitude, 75.0° W. longitude) are created at 15 and 45 min after the hour and on the hour and the half hour, respectively. From these data sets, the full disks (figure 4) and various sectors (1-, 2-, 4-, and 8-km resolution) are produced. For each of these areas the photographic display contains an equal amount of data points, thereby obtaining a finer resolution for the smaller regions. Each photographic display contains a legend at the top and is available gridded or ungridded.

An archive tape is made daily containing one visible and five infrared sectors from each satellite. Each sector consists of data viewed for approximately 89° of latitude and 99° of longitude starting at 50° N. latitude and centered in the east/west direction at the respective subsatellite positions.

Both the infrared and the visible data are archived at 7.4-km (4-mi) resolution. The times of the data archived each day under normal conditions (times may differ by ±1/2 to ±1 h) are

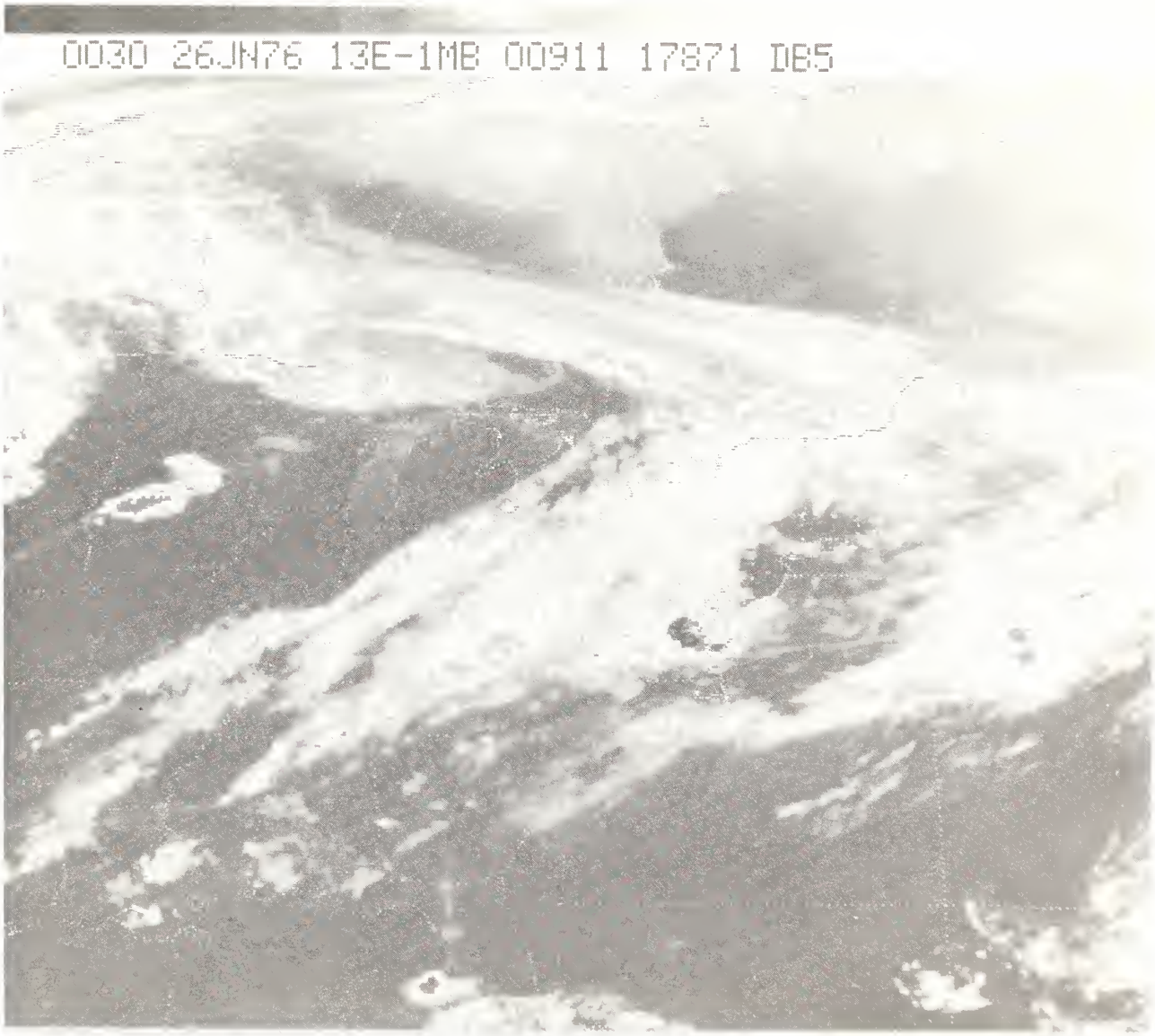


Figure 3.--Example of enhanced infrared photographic display.

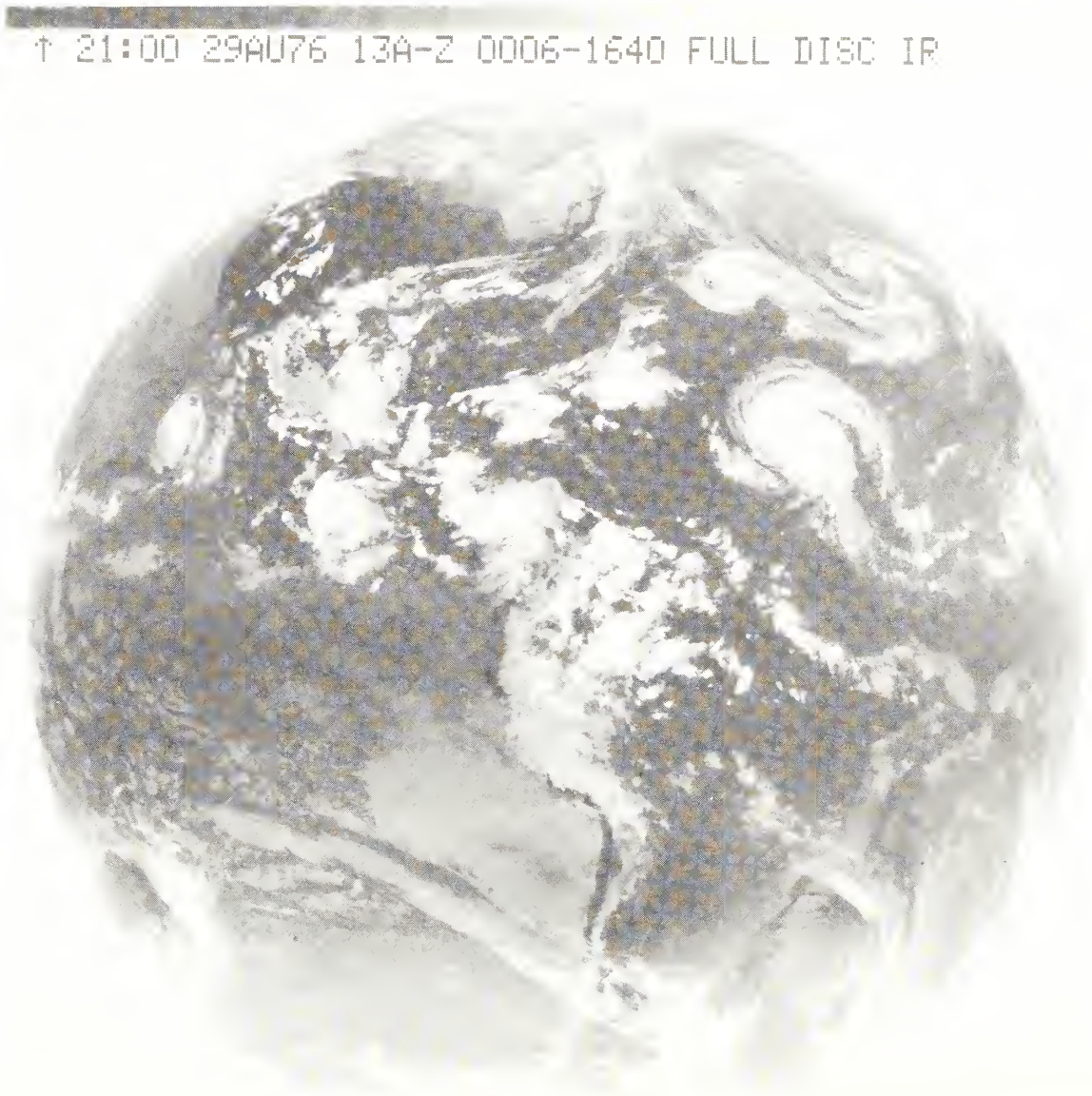


Figure 4.--Example of a full-disk photographic image (ungridded).

West Satellite (SMS-2)

0915Z (4-by-4-mi Infrared data)
0945Z (4-by-4-mi Infrared data)
1515Z (4-by-4-mi Infrared data)
1545Z (4-by-4-mi Infrared data)
2145Z (4-by-4-mi Infrared data)
2145Z (4-by-4-mi Visible data)

East Satellite (GOES-1)

0930Z (4-by-4-mi Infrared data)
1000Z (4-by-4-mi Infrared data)
1600Z (4-by-4-mi Infrared data)
1600Z (4-by-4-mi Visible data)
2130Z (4-by-4-mi Infrared data)
2200Z (4-by-4-mi Infrared data)

Full-disk and sector displays are very useful as a real-time source for the location of actual or potential severe weather and for issuing advisories to data-sparse areas, for following cloud motion and deducing wind speed and direction from successive pictures, and for use (in sequence) in producing movie films. As a research tool or in alerting forecasters to potential areas of concern, the photographic images may be altered by enhancing the data displayed (figure 3). An enhancement can emphasize areas of interest such as cloud tops, stratus decks, fog areas, etc., by alteration in the "gray scale" used.

Accuracy. The photographic displays are available in 8-, 4-, 2-, and 1-km resolutions. Accuracy in the positioning of clouds and their movements is limited to the fit and proper locating of the map grid to the data displayed. Map grid fitting is dependent on the ability to accurately pinpoint the subpoint of the satellite (Bristor 1975).

Primary users. The full-disk and sector displays produced by NESS are used primarily by the National Weather Service (NWS), National Meteorological Center (NMC), internally in NESS, and by a number of other Government, university, and research concerns. All of the SMS/GOES data are archived by the Satellite Data Services Branch (SDSB) of NCC either in negative form or on magnetic tape.

b. Direct Readout and GOES-Tap.

Description. The VISSR observations acquired by the SMS/GOES satellites can be received by ground stations in the areas shown in figure 1. With the installation of a ground station, users can receive near-continuous imagery at several resolutions, depending upon the mode of operation, 24 h each day (Rich and Popham 1975).

A service known as GOES-Tap is also available to users interested in receiving VISSR imagery transmitted to Satellite Field Service Stations (SFSS's) via landlines. Information on GOES-Tap can be obtained from

Chief, FSD, S122
U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite Service (NESS)
Washington, D.C. 20233

Persons interested in the construction of a direct readout receiving station should contact

Coordinator, Direct Readout Services, S12x1
NOAA, NESS
Washington, D.C. 20233

Primary users. Direct readout VISSR observations are used by foreign and domestic government agencies, universities, private consultant meteorological firms, research concerns, and amateur ground station operations. The GOES-Tap service is used mainly domestically.

c. Movie Loops.

Description. The movie loops generated in NESS (Bristor 1975) are one of the tools used in the application of satellite data to weather forecasting and research. Movie loops also are produced for display on commercial television stations.

The data used for making movie loops are photographic images produced from the geostationary satellites' VISSR sensors. These data, either infrared or visible, are combined into sequences of negatives separated by a half hour interval. After the selection of good quality negatives of any combination of various spatial resolutions, densities, or amounts, a computer program produces a 16-mm movie loop.

The computer programs involved in movie-loop generation produce three types of loops--"stop," "flow," and "alternate stop"--and one type of filmstrip for commercial TV display. The movie loops consist of 80 or more frames, the lengths of which depend on whether the loop is a "stop" or a "flow." A stop loop has the beginning and end scenes repeated for a minimum of 16 frames, with intervening scenes repeated once, while an alternate stop loop has alternating flow and stop segments. The flow loop holds the first scene and repeats 4 to 26 subsequent scenes only once. Filmstrips created for commercial TV display are in the form of a "stop" but are not closed into a loop. These movies are put through a rigid quality-control procedure by man and computer software to assure evenness of illumination and proper registration. Each movie loop or strip contains the date and start and end times located in the lower right-hand corner. A computer list of movie loops currently used in-house by NESS is in table 1.

The Satellite Winds movie loops (see Satellite Winds under METEOROLOGICAL SERVICES) and the TV filmstrips are archived at the SDSB of the Environmental Data Service (EDS). Movie loops prepared for the Applications Group are on file in that group and are available to in-house personnel.

Primary users. The movie loops are used by the Applications Group of NESS for its morning briefings. Another set of loops are prepared for the Satellite Winds Section for its winds program. TV filmstrips with written discussion of the weather conditions shown are made available once per day to commercial stations.

Table 1.--Movie loops available as of August 27, 1976

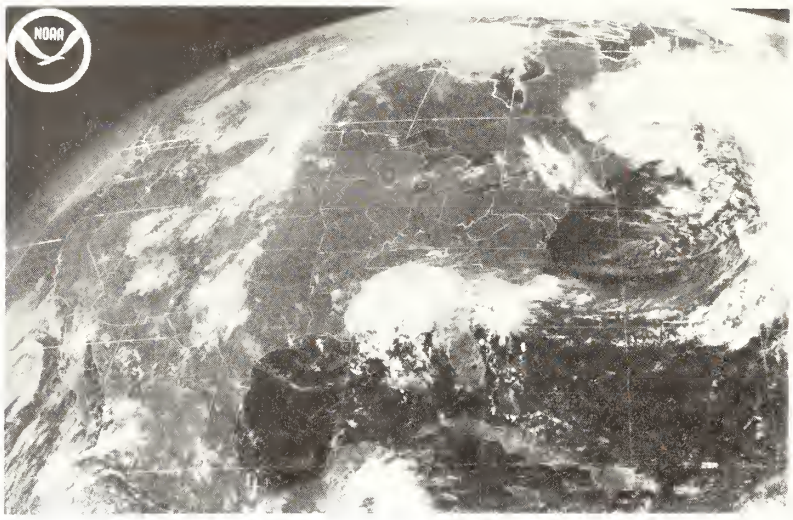
Sector	Description	Satellite	VIS/IR/IR enhanced	Resolution
WB1	United States	GOES-1	VIS	2 km
WB2	United States and West Pacific	SMS-2	VIS	2 km
DA1	East United States	GOES-1	VIS	1 km
KA3	Gulf of Mexico	GOES-1	VIS	1 km
	Northern Hemisphere/ United States and Atlantic	GOES-1	IR	8 km
	Northern Hemisphere/ United States and Pacific	SMS-2	IR	8 km
	North America/ United States	GOES-1	IR enhanced	8 km
	West Coast United States	SMS-2	IR enhanced	8 km
	Tropical Pacific/West of Paha (hurricane season only)	SMS-2	IR enhanced	8 km
	Florida split frame	GOES-1	VIS & IR enhanced	2 & 8 km
DA1	DA1 split frame	GOES-1	VIS & IR enhanced	2 & 8 km
	Hawaii	SMS-2	IR enhanced	8 km
	TV filmstrip-- United States	GOES-1	IR	8 km

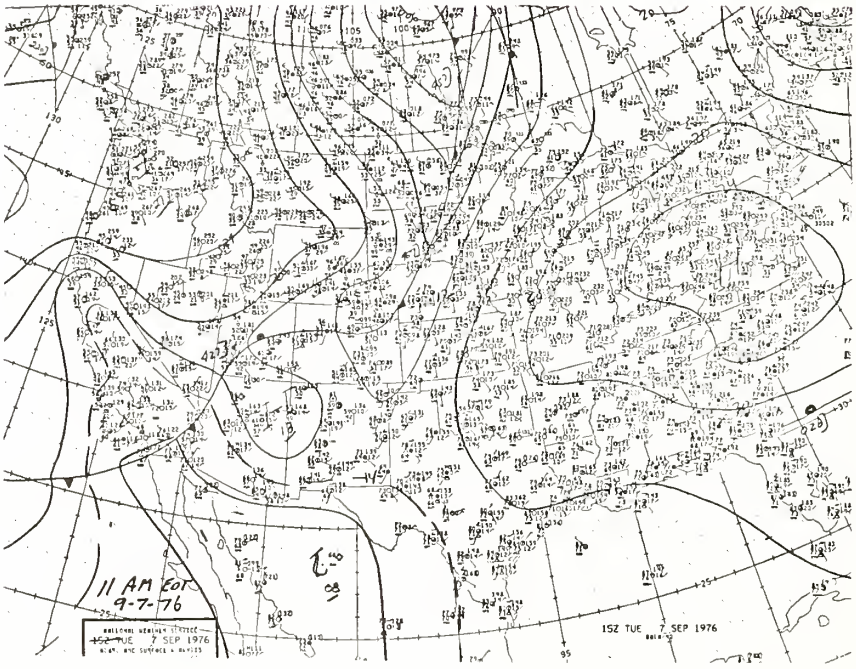
d. U.S. Cloud Cover Depiction.

Description. The U.S. Cloud Cover Depiction is sent out to the news media wire services via landline and to in-house users by mail once per day. The product used in-house (figure 5) consists of a photographic display, normally the 17Z image, an NMC 15Z surface analysis, and a brief narrative description of the location of cloud cover and weather over the continental United States. These are approximately 20 by 25 cm in size. The wire services receive a photographic display and discussion combined for facsimile transmission. This product is useful for briefings and local displays of current weather.

Primary users. The U.S. Cloud Cover Depiction is used by members of NOAA Headquarters, NESS, Environmental Research Laboratories (ERL's), NASA, Department of Defense, and the news media wire services. This product is archived by the SDSB, Inc.

U.S. CLOUD COVER
7 SEPTEMBER 1976 1700 GMT
NASA/NOAA SATELLITE PHOTOGRAPH
NATIONAL ENVIRONMENTAL SATELLITE SERVICE





SMS GOES DAILY WEATHER PICTURE FOR: SEPTEMBER 7, 1976

AN AREA OF CONSIDERABLE CLOUDINESS AND THUNDERSTORMS EXTENDS FROM THE SOUTH ATLANTIC COAST WESTWARD TO MISSISSIPPI. A BAND OF FRONTAL CLOUDS, BROKEN IN SOUTHERN PORTIONS, EXTENDS FROM THE WESTERN DAKOTAS SOUTHWESTWARD TO UTAH. OTHER CLOUDS ARE VISIBLE OVER WESTERN TEXAS AND IN NEW YORK.

Figure 5.--Example of the U.S. cloud cover depiction--photographic display, surface analysis, and narrative description.

2. Facsimile

a. SMS/GOES Facsimile Displays Transmitted on Standard FAX Circuits.

Description. The data received from the VISSR sensor on board the SMS/GOES series of geostationary satellites are used in the computer-derived production of gridded and unrectified facsimile displays (figure 6). These displays present the data in an unaltered form (unrectified) with an overlay of latitude and longitude lines and the outlines of land masses and U.S. State boundaries. The resolution of visible data is 4 by 4 km and infrared 4 by 8 km. A few displays are also transmitted in the form of polar-stereographic and Mercator projection of a 1:30M and 1:120M scale, respectively.

Each facsimile image contains a legend providing satellite name, type of data (visible--VIS, infrared--IR), resolution (miles), and date (month/day/year) and time (GMT) of observation. The transmissions are sent on standard facsimile circuits at a rate of 120 lines per minute in 16 shades of gray. A list of facsimile products, the areas covered, and their times of transmission can be obtained from

NOAA/NWS, W534
8060 13th Street
Gramax Building
Silver Spring, Md. 20910

Facsimile displays find their usefulness in the determination of cloud cover, cloud-top heights, and type, structure, patterns, and behavior of specific circulation systems. When periods occur in which other data sources become unavailable, facsimile images can be used as a substitute. With the collection of a series of images, local scene changes can be observed revealing small-scale motions, convective activity, and diurnal and differential heating effects.

Primary users. Satellite facsimile displays are used by the NWS, Department of Defense (DOD), private meteorologists, universities, research concerns, and internally in NESS.

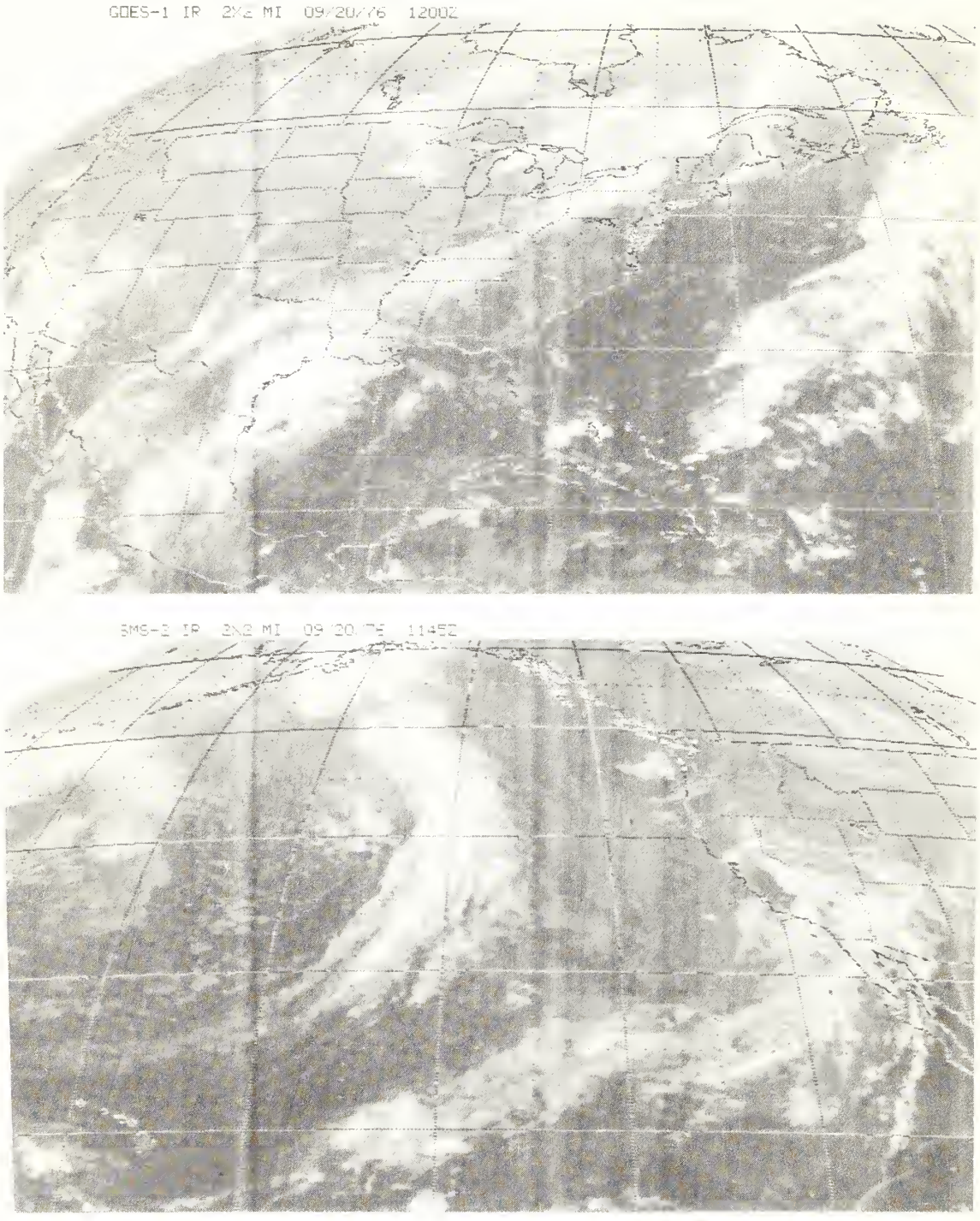


Figure 6.--Examples of gridded and unrectified facsimile displays of SMS/GOES VISSR data.

b. SMS/GOES WEFAX.

Description. A service known as Weather Facsimile (WEFAX) is available to the Automatic Picture Transmission (APT) receiving community having S-band receivers. The area of reception from the SMS or GOES satellites is shown in figure 1. Both mapped Scanning Radiometer (SR) data from the NOAA polar-orbiting satellites and unmapped VISSR data from the SMS/GOES series geostationary satellites are processed in the NESS computer system and broadcast via the SMS/GOES satellites. The polar-stereographic mapped SR images (figure 7) and the unmapped VISSR images (figure 8) have a resolution of approximately 8 km and, depending on the schedule, may contain infrared or visible imagery. Each broadcast contains two displays and each display contains a legend providing the originator's identification, source of data (satellite identification), date, time(s) of data acquisition (in GMT), geographic location, data channel, and, at times, a supplemental coded message. Updated schedules are also transmitted when they occur. Information on APT/WEFAX ground receiving equipment and a list of WEFAX products and their time of transmission can be obtained from

Coordinator, Direct Readout Services, S12x1
U.S. DOC, NOAA, NESS, FB-4
Washington, D.C. 20233

Primary users. WEFAX displays are used by foreign and domestic weather concerns with APT S-band receiving equipment.

Figure 7.--Example of SMS/GOES WEFAX mapped SR image.

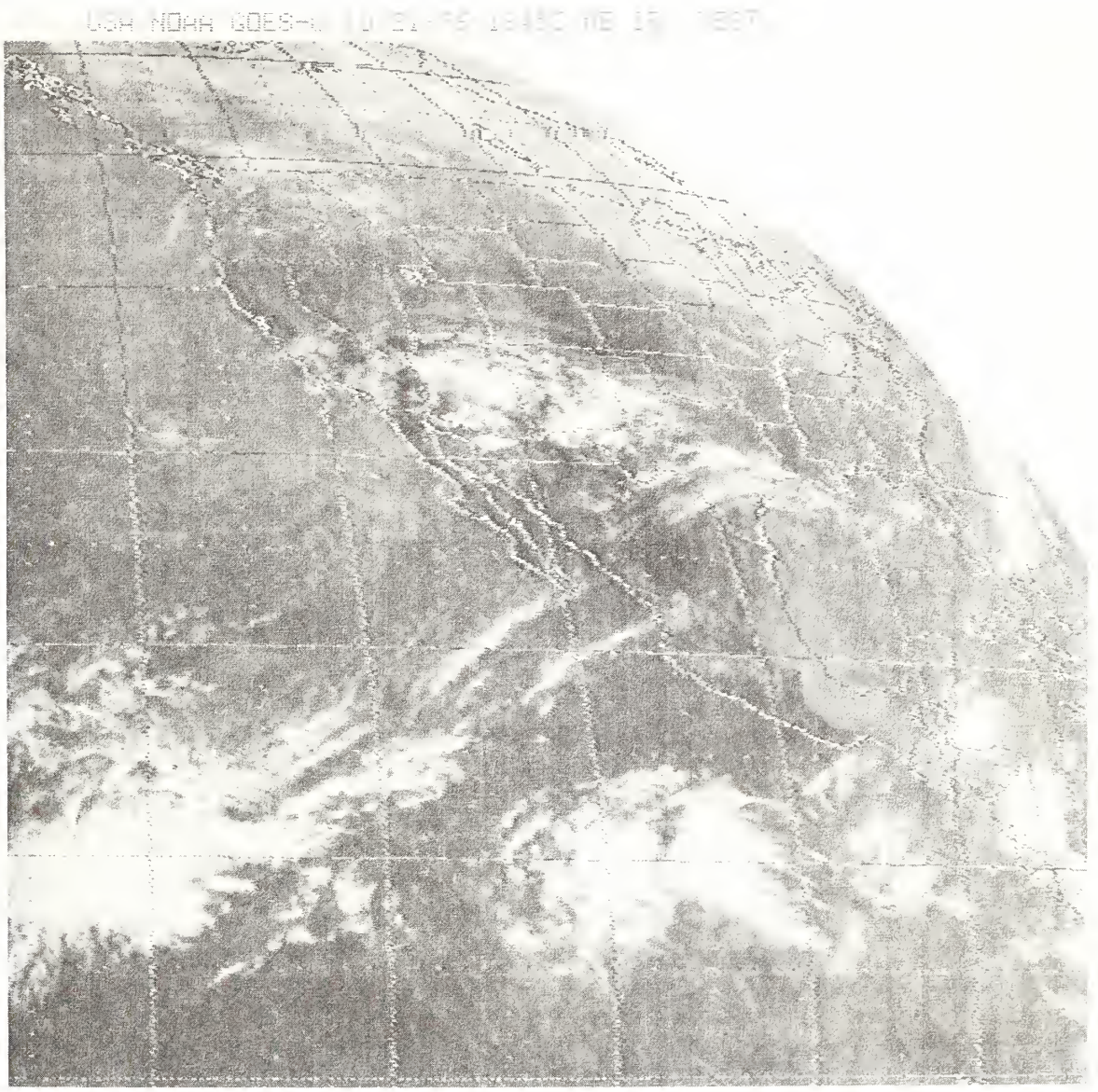


Figure 8.--Example of SMS/GOES WEFAX unrectified VISSR image.

c. ATS WEFAX.

Description. A service known as WEFAX is available through the Applications Technology Satellite (ATS) series' satellites to the APT receiving community having VHF receivers. The photographic data transmitted through this system are the mapped (rectified, gridded) imagery obtained from the SR on board the NOAA polar-orbiting satellite. Rectification transforms the observed data into either a Mercator (figure 9) or polar-stereographic projection (figure 10). Both visible and infrared data are available in either 4 by 4-km or 4 by 8-km resolution. A legend appears at the top of each display providing source of data (satellite identification); number, date (day/month/year), and time (GMT) of first pass displayed; and type of data (VIS, IR). Geographic location is provided within the display.

A list of WEFAX products[2] and their time of transmission can be obtained from

Coordinator, Direct Readout Services, S12x1
U.S. DOC, NOAA, NESS, FB-4
Washington, D.C. 20233

Primary users. WEFAX displays are used by foreign and domestic weather concerns with APT VHF receiving equipment.

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[2]ATS/WEFAX will be available as long as the ATS-1 and -3 satellites are operative.

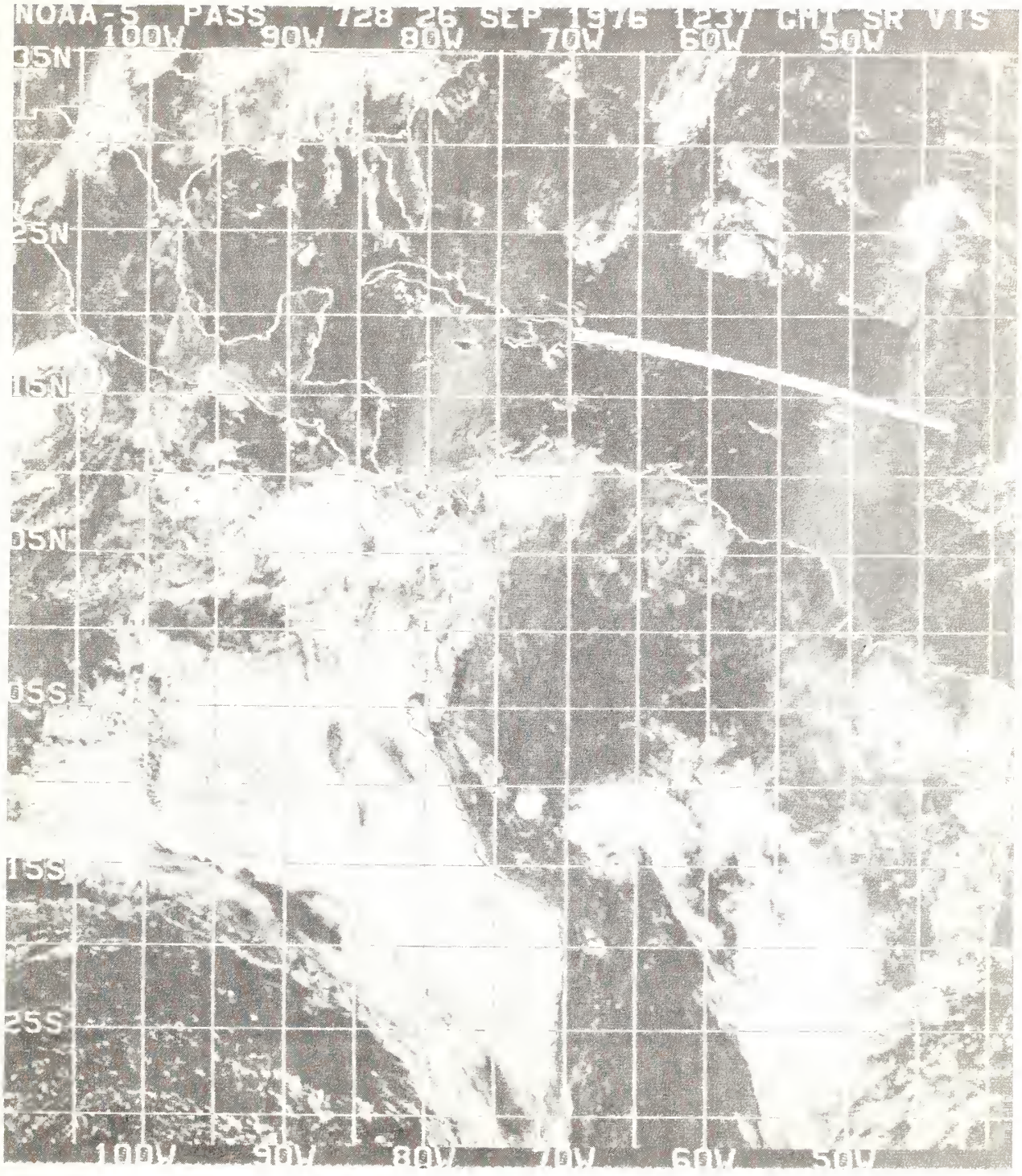

Figure 9.--Example of ATS WEFAX mapped Mercator SR image.

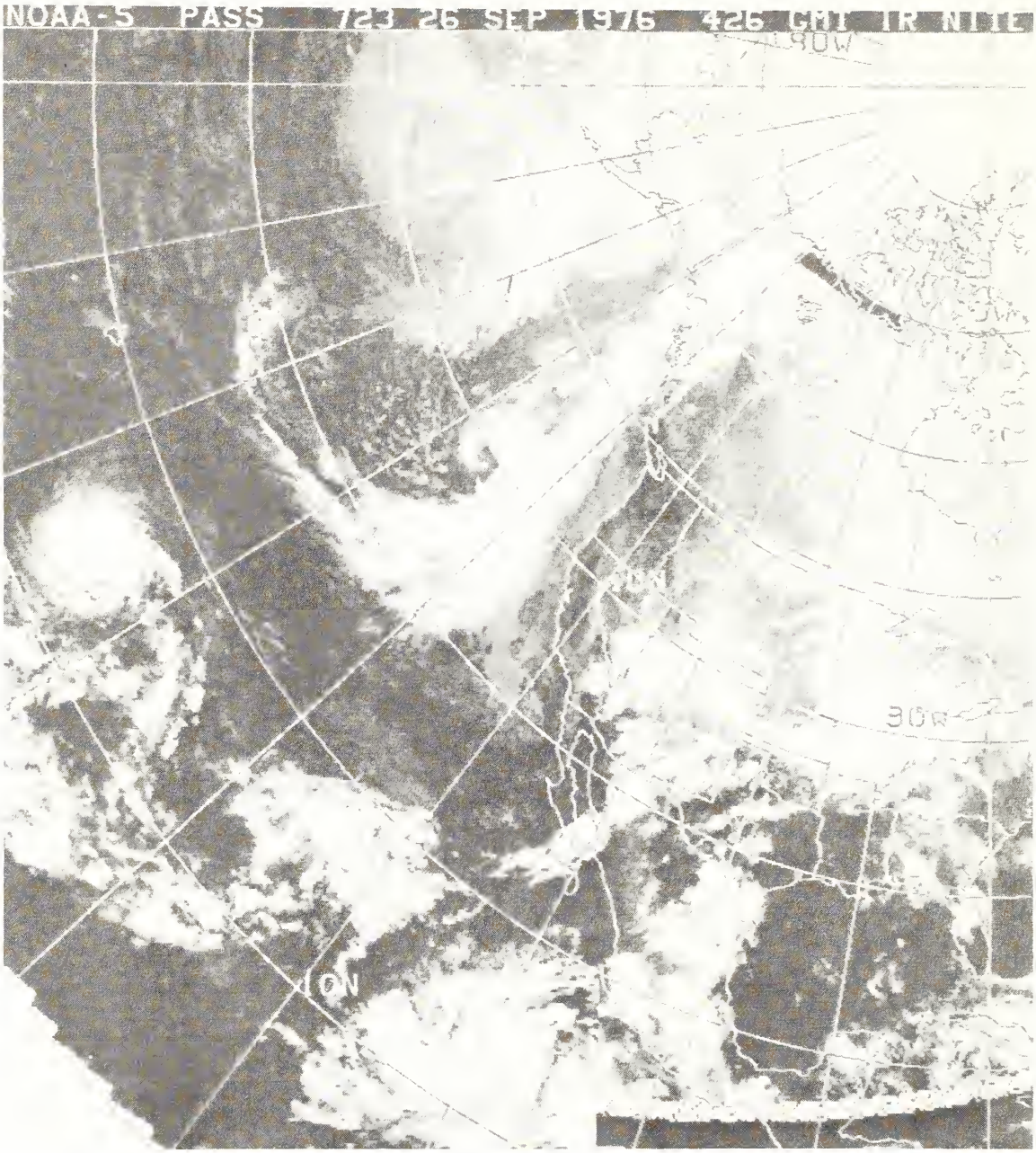

Figure 10.--Example of ATS WEFAX mapped polar-stereographic SR image.

B. Polar-Orbiting Satellites

1. Photographic Imagery (Computer Derived)

a. Stretched, Gridded Pass-by-Pass SR Images.

Description. The individual swaths shown in figure 11 are produced after each satellite pass. These swaths provide complete coverage from pole to pole. Pass-to-pass contiguity is achieved by lateral east-to-west overlapping of the images. The process begins with the digitizing of the raw image signal. From there, the response values are adjusted by use of a concurrent voltage wedge. The voltage-to-count normalized responses are then adjusted ("stretch") to remove scene foreshortening near the horizons. This is accomplished through differential sample replication; the result is an equal area image. Latitude/longitude gridlines and coastal outlines are automatically melded with the image prior to display.

The polar-orbiting satellite follows a path shown in figure 12. From these tracks, 12 to 13 stretched gridded strips (computer-produced grids fitting 1:1 aspect ratio data) are made using visible data and, when tropical storm coverage is needed, selected infrared nighttime data are produced.

The photographic image produced is a set of two panels of 6.5-km resolution, each 14.5 by 22.0 cm, which can be joined together to produce a continuous pole-to-pole strip. The legend, which appears at the beginning and end of a complete strip, provides satellite name; pass number; track number; sensor number; type of SR data displayed (day VIS or night IR); month, day, and year of pass; time (hours/minutes/seconds) in GMT of the first SR scan being displayed (top legend) and the time of the last SR scan (bottom legend); and spacing of the latitude and longitude grids in degrees.

Included with the legends are two display wedges and a calibration wedge at the bottom. The display wedges are in three parts consisting of three selectable display tables which may be applied over five scan sectors to optimize either visual imagery under varying illuminations or IR response as a function of latitude, i.e., from 40° S to 40° N. The calibration wedge is used to calibrate the photofacsimile equipment.

Stretched gridded strips provide users with a "quick look" and a view of the scene in the perspective and spatial resolution of the original signals.

The data in the visible part of the spectrum are used for general meteorological applications such as the determination of cloud coverage, cloud types, and systematic patterns of cloudiness. The information may be used separately or together with conventional weather data to determine the structure and behavior of specific circulation systems.

Over data-sparse regions, the satellite data are used as a substitute for conventional data. Models have been developed to relate the structure and patterns of clouds to conventional data. By using these relationships, bogus wind and density data can be inferred for use in standard analysis or in numeral forecasting models.

The picture may be used in sequence to observe changes of weather patterns at the synoptic or larger scales. Data are also time-composited for climatological and hydrological uses.

Nighttime infrared data are used to determine the approximate temperatures of the emitting surfaces. From these, the type of surface observed can be distinguished, and the heights of cloud tops can be estimated. Although visible data are not obtained at night, the cloud-top information may be used to aid in the interpretation of visible data from the nearest daylight observation. The night IR data also are used along for general meteorological interpretation of cloud coverage, type, and pattern.

Primary users. The stretched gridded strips are used internally by NESS and by NWS and DOD. These data are archived by the SDSB of NCC.

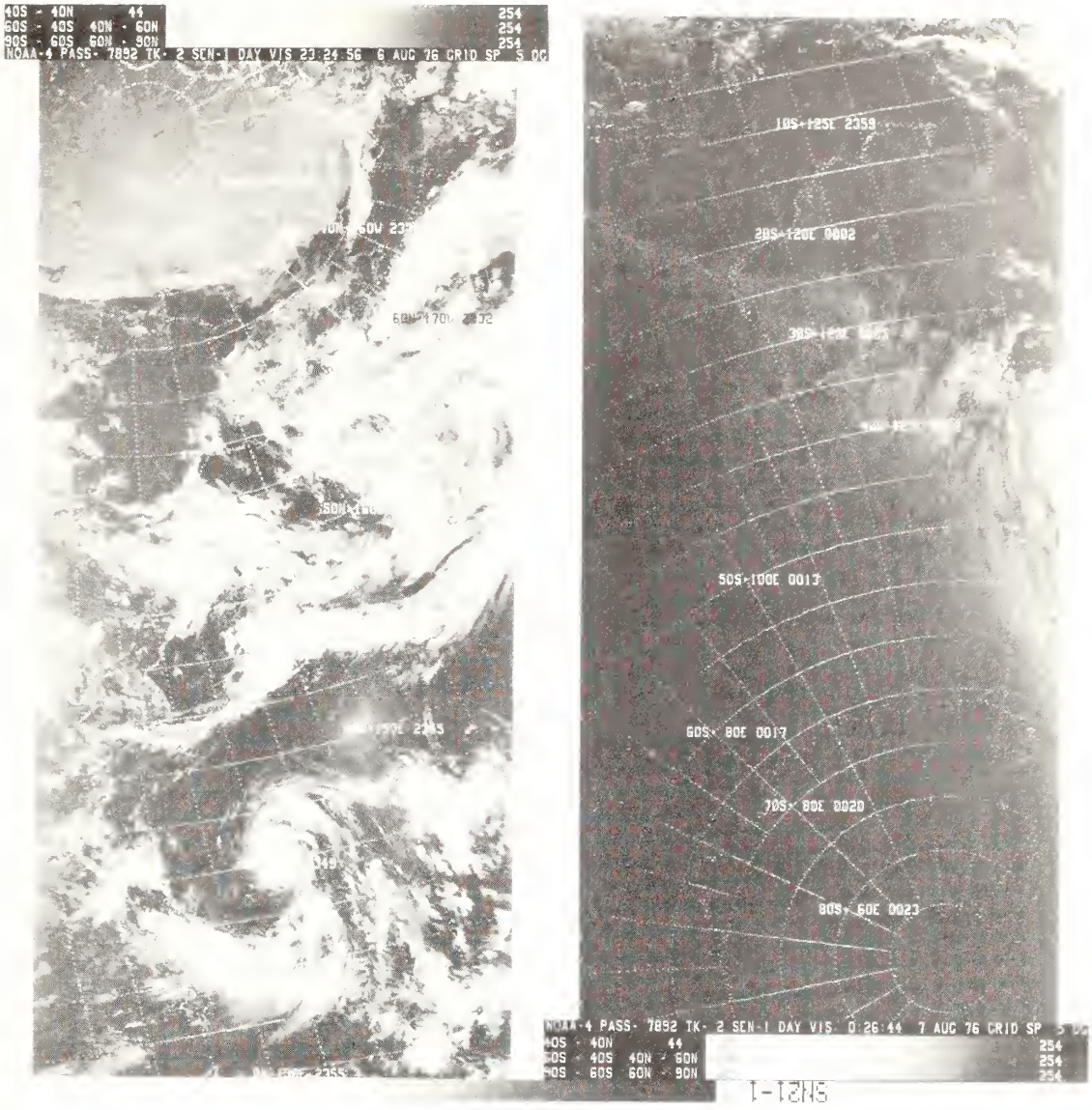

Figure 11.--Example of stretched-gridded and unrectified pass-by-pass SR image.

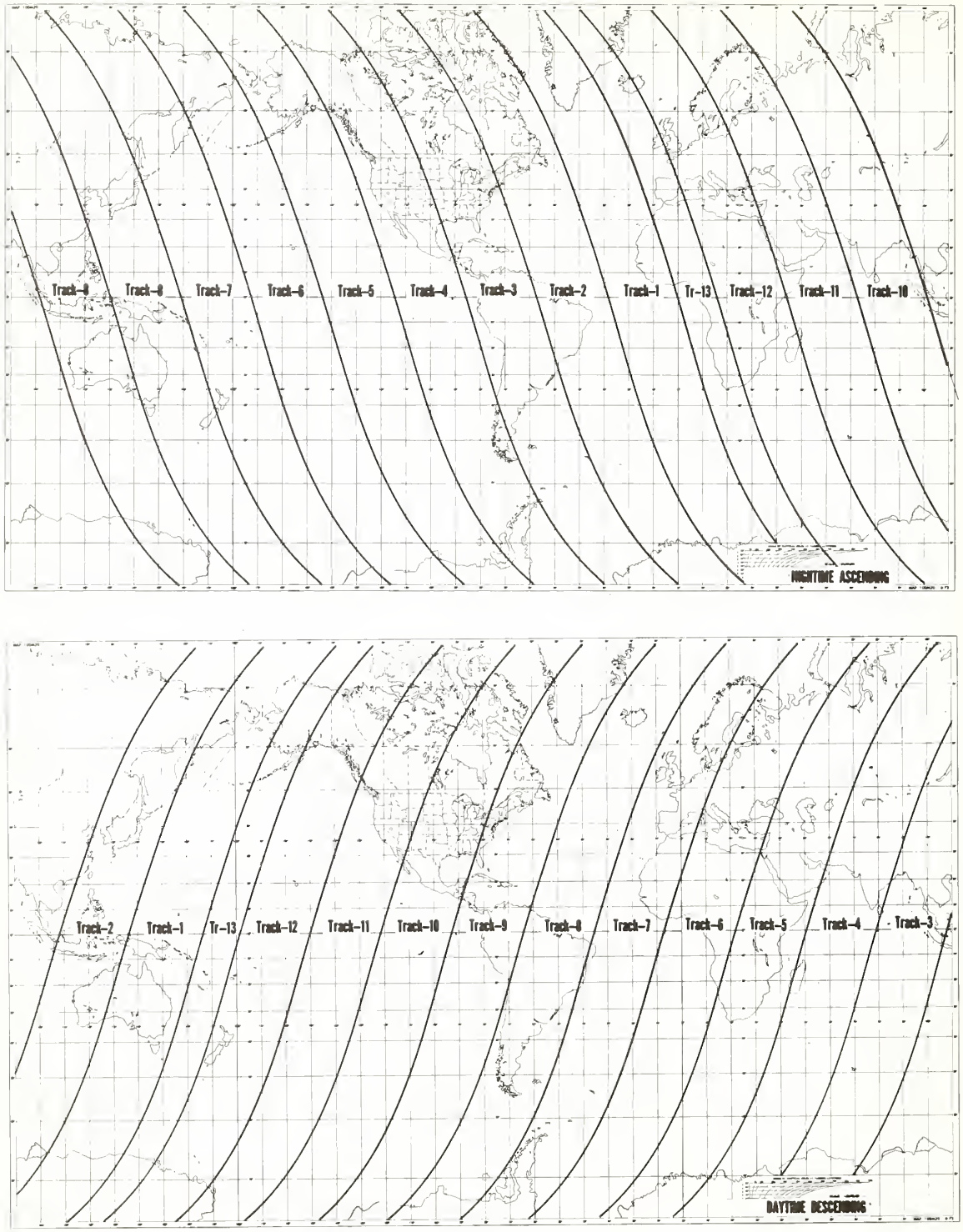

Figure 12.--Tracks of polar-orbiting satellite's subsatellite point.

b. SR Hemispheric Polar-Stereographic Mosaics.

Description. From a combined 24-h set of scanning radiometer data observed by the polar-orbiting satellite, seven polar-stereographic (1:30M) mosaics are made (figures 13-15)--Northern Hemisphere: VIS, IR day, IR night, VIS half hemisphere (10° E-170° W), and Southern Hemisphere: VIS, IR day, IR night. These photographic displays are produced at about 14Z and 23Z for daytime and nighttime observations, respectively.

The process involves the accumulation of data on a disk in a 1,024-by-1,024, 8-byte, polar array for each hemisphere. The array is alined so it represents a subdivision of the Numerical Weather Prediction (NWP) grid system. Visible channel signals are brightness normalized to reduce the effect of varying solar illumination angles. The infrared signals are corrected for limb darkening (atmospheric absorption) caused by viewing at various angles.

The initial product is a 25-by-25-cm negative film transparency of both the Northern and Southern Hemispheres from which photographic prints are made. The half Northern Hemisphere VIS is a separate display. These negatives are archived at the SDSB of the National Climatic Center (NCC) along with a data tape of each mapped mosaic. A monthly booklet ("Environmental Satellite Imagery," published by the U.S. Department of Commerce) of archived hemispheric polar-stereographic mosaics is available through the National Technical Information Service (NTIS).

A legend appears at the top of each display providing the satellite name; name of display (hemisphere, sensor, VIS, IR day, IR night); beginning orbit number, date (month/day/year), and time (GMT); and ending orbit number, date, and time. The time passage of the satellite across the equator at six locations also is given on the display to help time-reference the data.

Above the legend are three gray-scale wedges. The top wedge includes the recorder device number and a machine-produced scale used to calibrate the film recorder equipment. The middle scale is a data gray scale that depicts the range of the data. The bottom scale is also a data gray scale but in linear form.

In the upper right corner of each infrared mosaic appears a box depicting the gross quantitative relation between gray tone and temperature in degrees Celsius. To accommodate the different temperature ranges that occur in tropical, temperate, and polar

zones, a particular temperature range is represented in the box by gray tones that vary with latitude. By taking into account the cooler temperatures of higher latitudes, the sealing is arranged so only clouds will appear white or nearly white.

The applications of the daytime visual channel data and nighttime infrared data are the same as described in the Stretched, Gridded Pass-by-Pass SR Images section. Daytime infrared data are used to determine relative cloud-top heights as a function of the temperatures derived from these data. A major application is to supplement visible satellite data by relating the cloud-top heights to other characteristics in distinguishing cloud type and structure. However, when no visible data are available, the IR data may be used alone for general meteorological interpretation.

Primary users. Hemispheric polar-stereographic mosaics are used by NESS, ERL's, and DOD, and are archived by the SDSB of NCC.

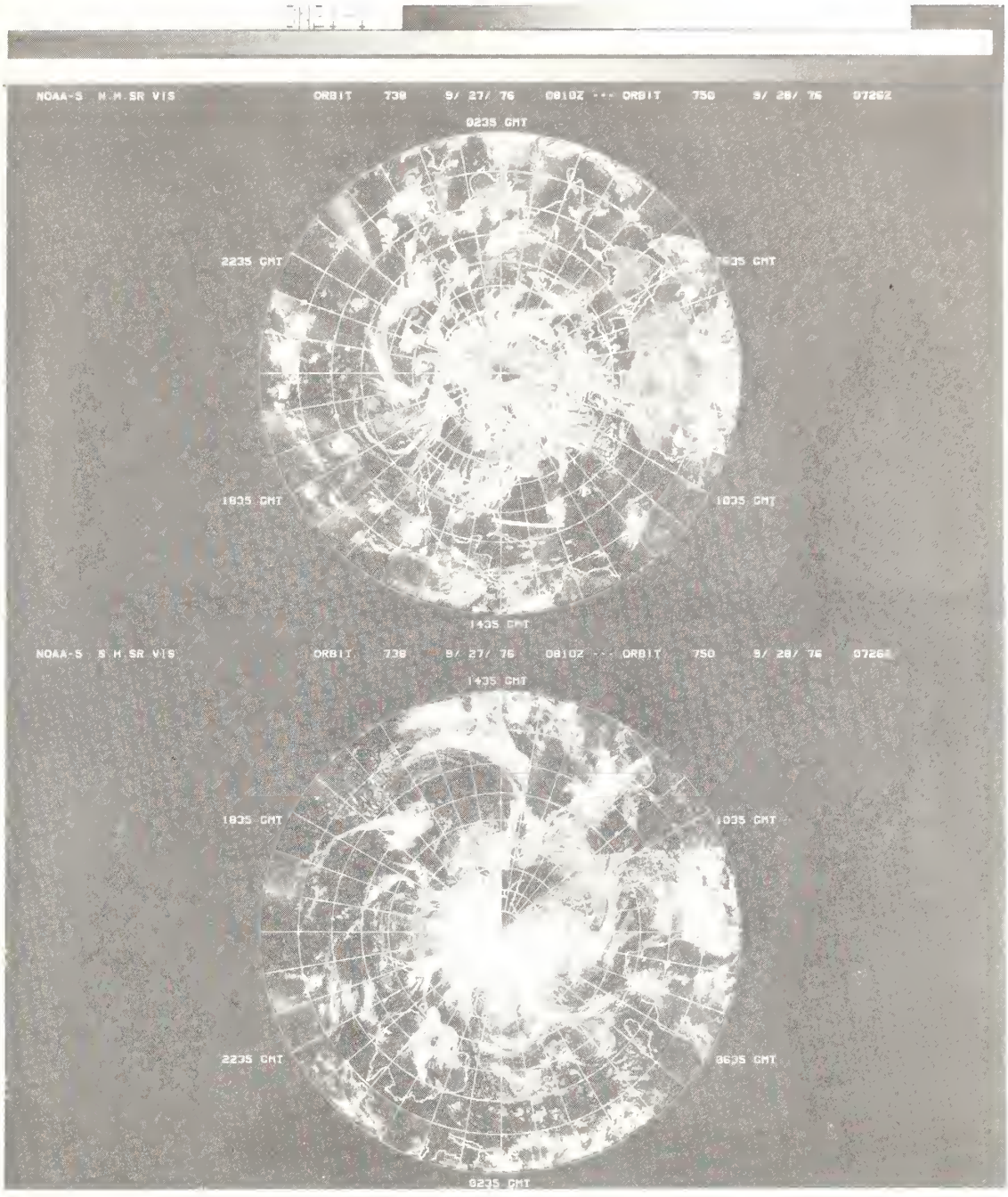

Figure 13.--Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, visible data).

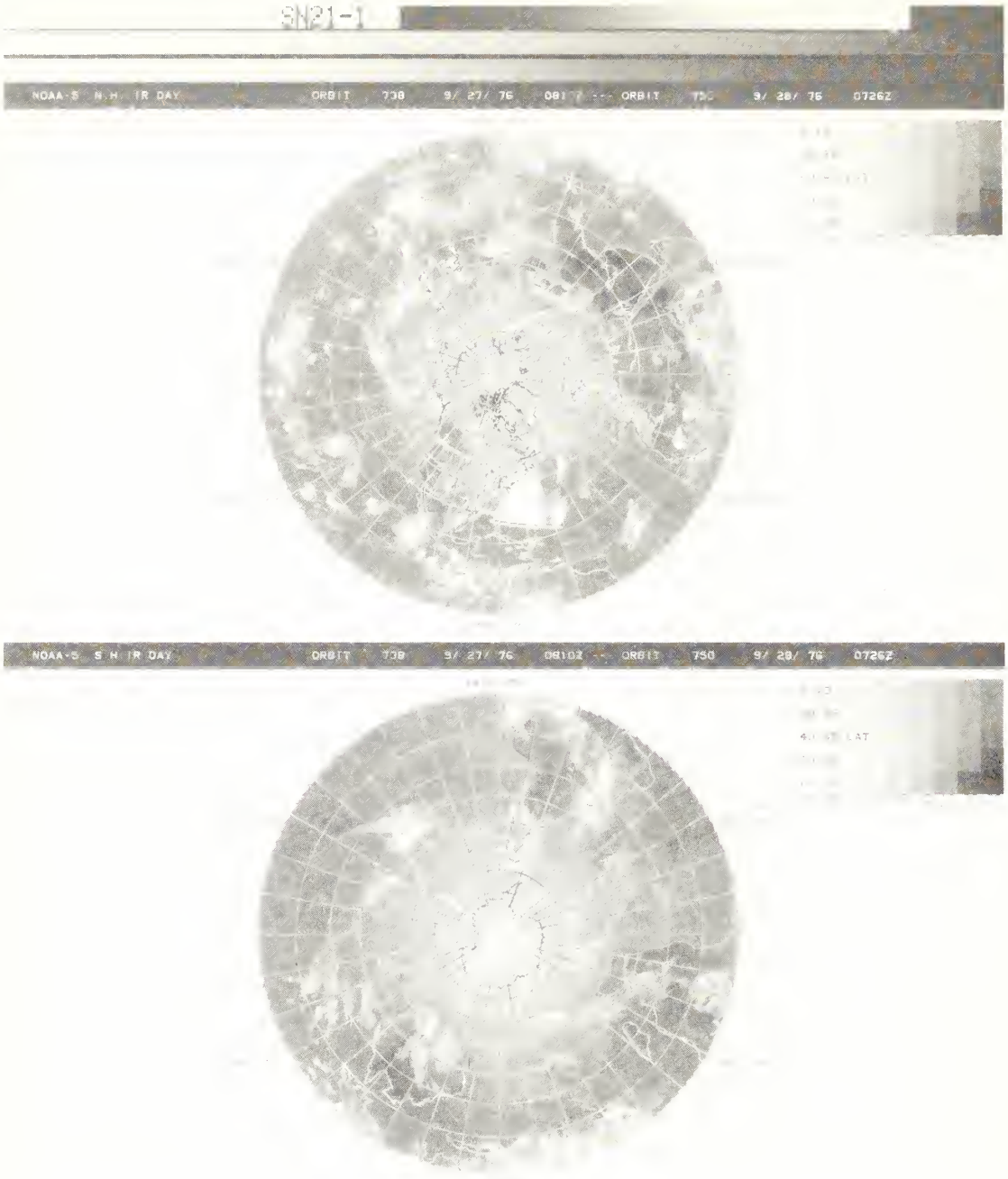

Figure 14.--Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, infrared daytime data).

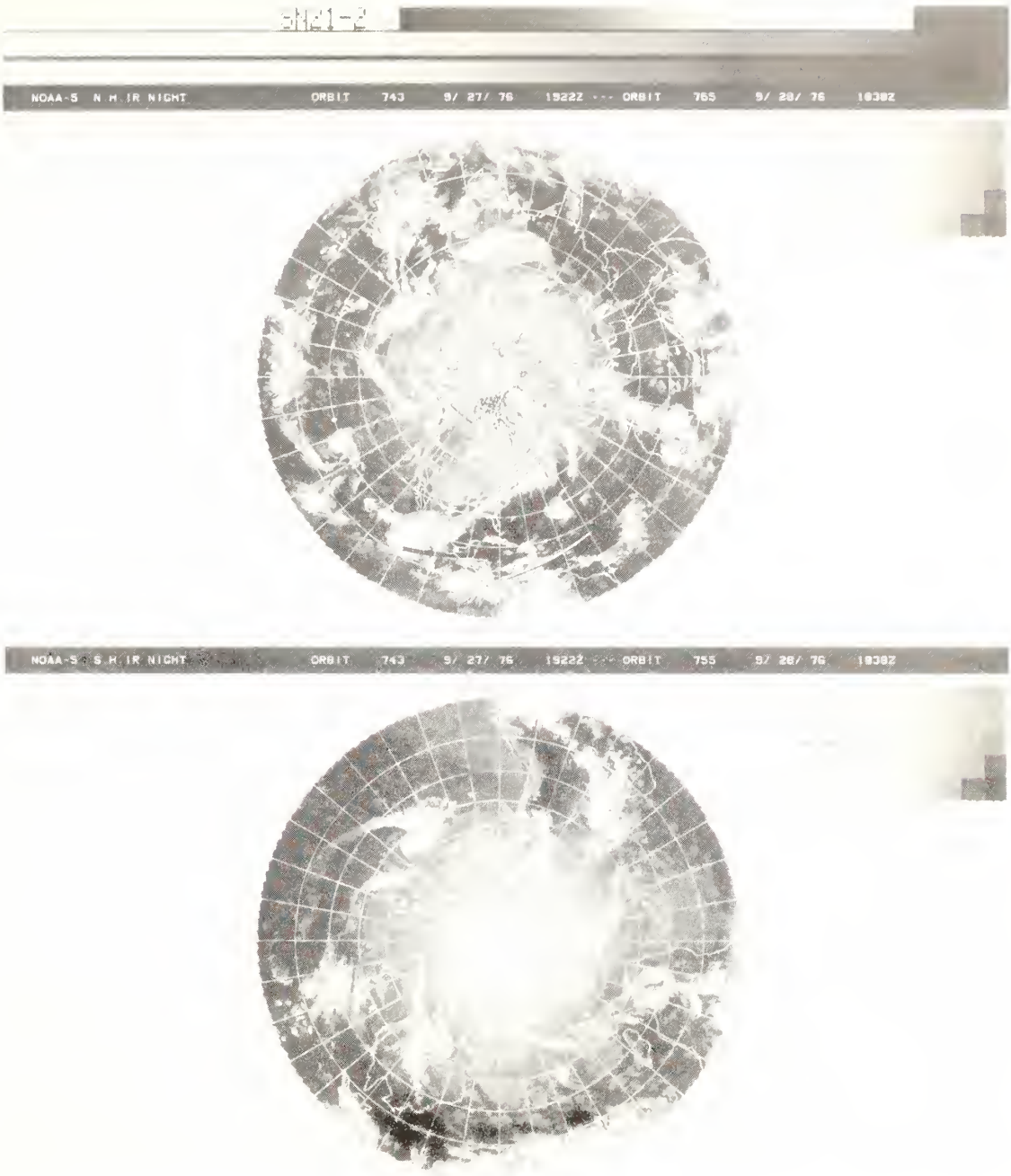

Figure 15.--Example of SR hemispheric polar-stereographic mosaic (Northern Hemisphere view, infrared nighttime data).

c. SR Polar-Stereographic Quadrant Mosaics.

Description. The polar-stereographic quadrant mosaics (figure 16) are SR displays (1:30M) of one-quarter of a hemisphere made up of up to four passes of the polar-orbiting satellite per quadrant. Three types of displays are made for each hemisphere: VIS, IR day, and IR night. The VIS and IR day are available about 04Z, 09Z, 18Z, and 23Z, and the IR night displays around 04Z, 10Z, 18Z, and 20Z.

The computer software and data base used to produce this product are the same as those mentioned for SR Hemispheric Polar-Stereographic Mosaics.

Each quadrant negative is 5 by 5 cm, enlarged to 31 by 31 cm for printing. No negative or print archive is made from this product.

The legend that appears at the top of each quadrant provides the time of processing (year/sidereal day), view number (1-8), hemisphere, type of data, longitudinal coverage, and pass numbers including date and time of satellite equatorial crossing. A gray scale is given at the bottom of each quadrant to allow for the calibration of the film recorder equipment.

Polar-stereographic quadrants serve the same purpose as that described under Stretched, Gridded Pass-by-Pass SR Images and SR Hemispheric Polar-Stereographic Mosaics. These displays are enlargements of the hemispheric mosaics, covering up to four passes. This makes them more useful for positioning of synoptic patterns, determination of cloud coverage, etc., for the synoptic user.

Primary users. This product is used by NESS, NWS, and DOD.

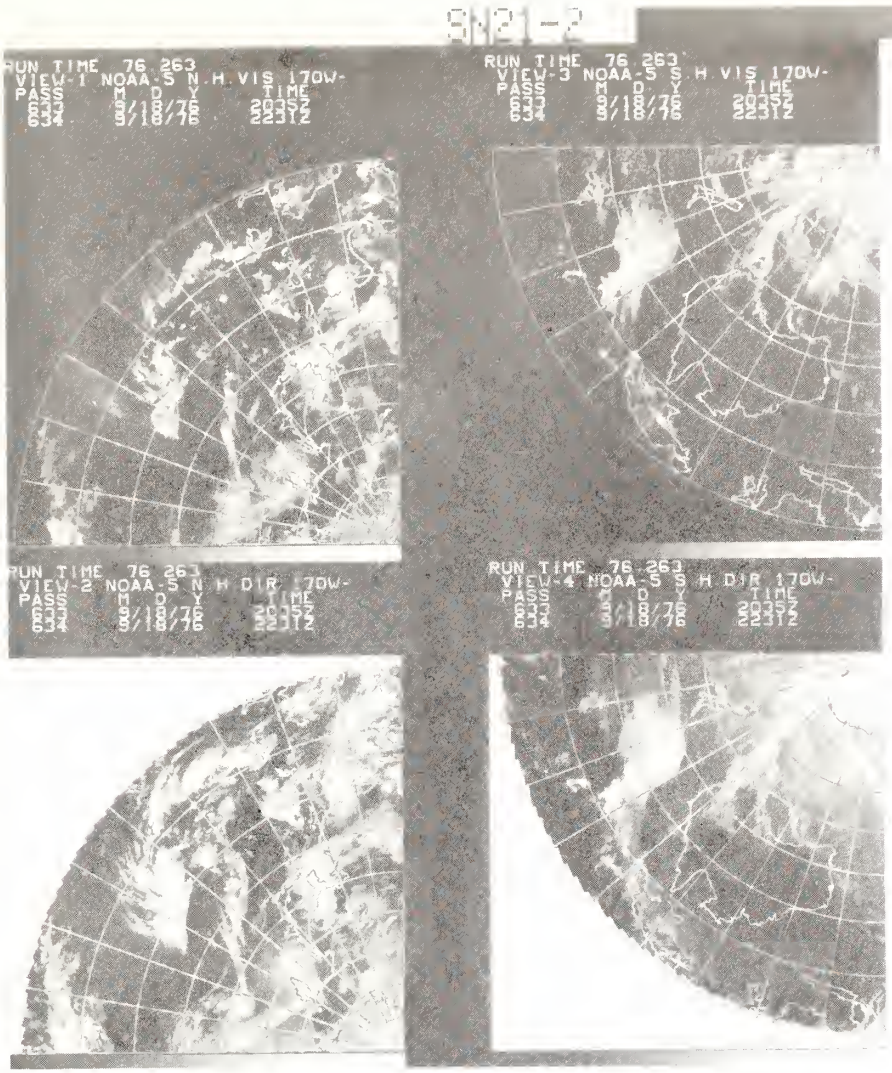

Figure 16.--Example of four SR polar-stereographic quadrant mosaics.

d. SR Mercator Mosaics.

Description. The Mercator mosaics are made from 24 h of stored scanning-radiometer observations as viewed from the polar-orbiting satellite. These mosaics cover from 40° S to 40° N latitude comprising the total 360° of longitude in two sections (figures 17 and 18).

The computer software involved in producing the mosaics imposes a square mesh array (4,050 column by 984 row) on a Mercator projection scaled 11.25 map elements per degree of longitude at the equator. A resolution of 10 km at the equator crossing is achieved with this display increasing to 8 km at 40° N or S. The data are mapped in 6-bit (64 shades of gray) quantities, once per day, producing three displays: VIS, IR day, and IR night. The SR VIS and IR day are available at approximately 14Z and the IR night at 23Z. Negatives of each display are archived at the SDSB.

The legend located at the bottom of each display gives the satellite name, first and last pass number used in the composite, date of first pass (month/day/year), and the type of data displayed.

Gray scales located at the top of each display are used to calibrate the film recorder equipment.

The applications of this product are the same as that mentioned under SR Hemispheric Polar-Stereographic Mosaics and Stretched, Gridded Pass-by-Pass SR Images.

Primary users. These mapped mosaics are used by NESS, NWS, ERL's, and DOD.

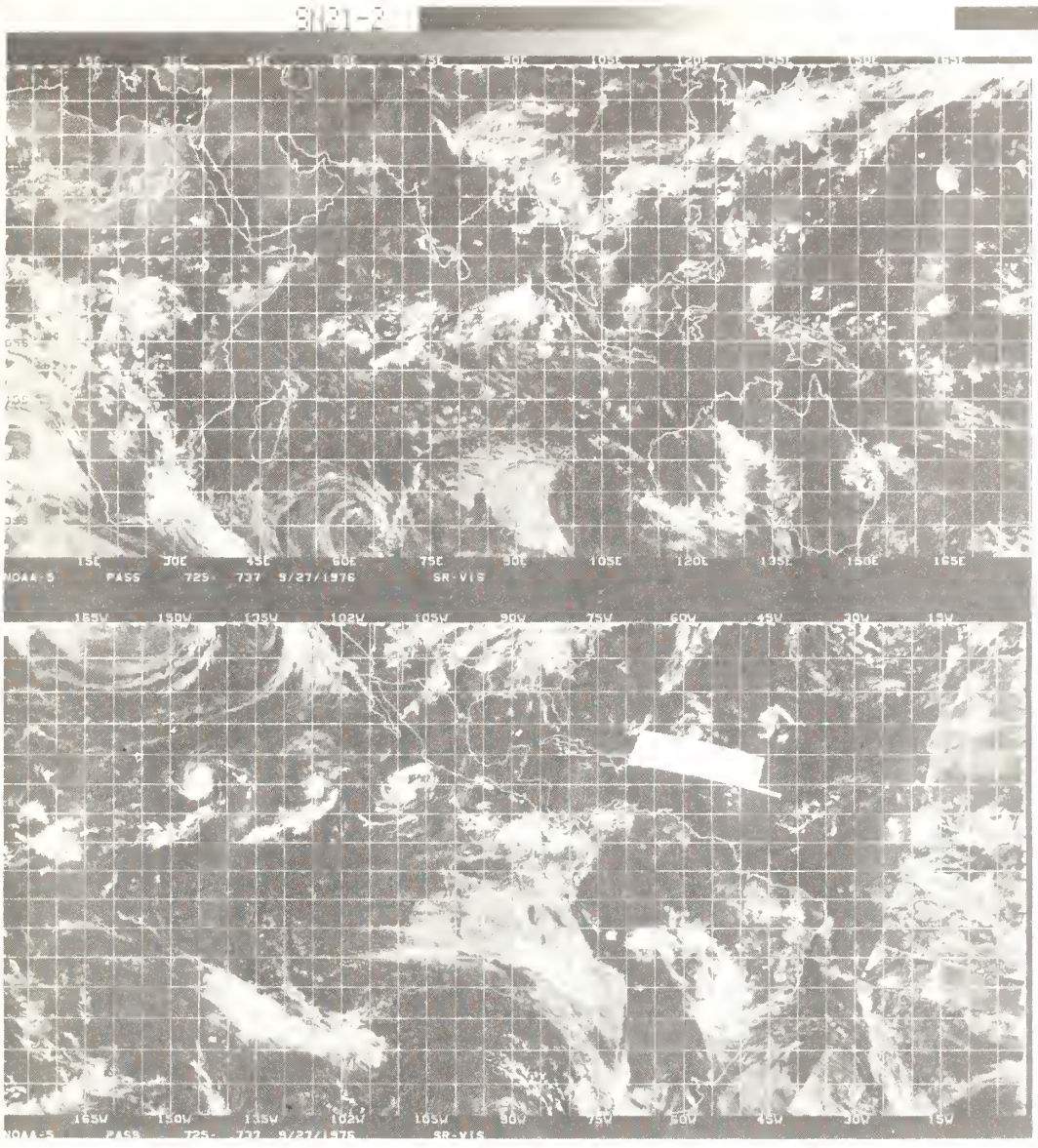

Figure 17.--Example of SR Mercator mosaic (visible data).

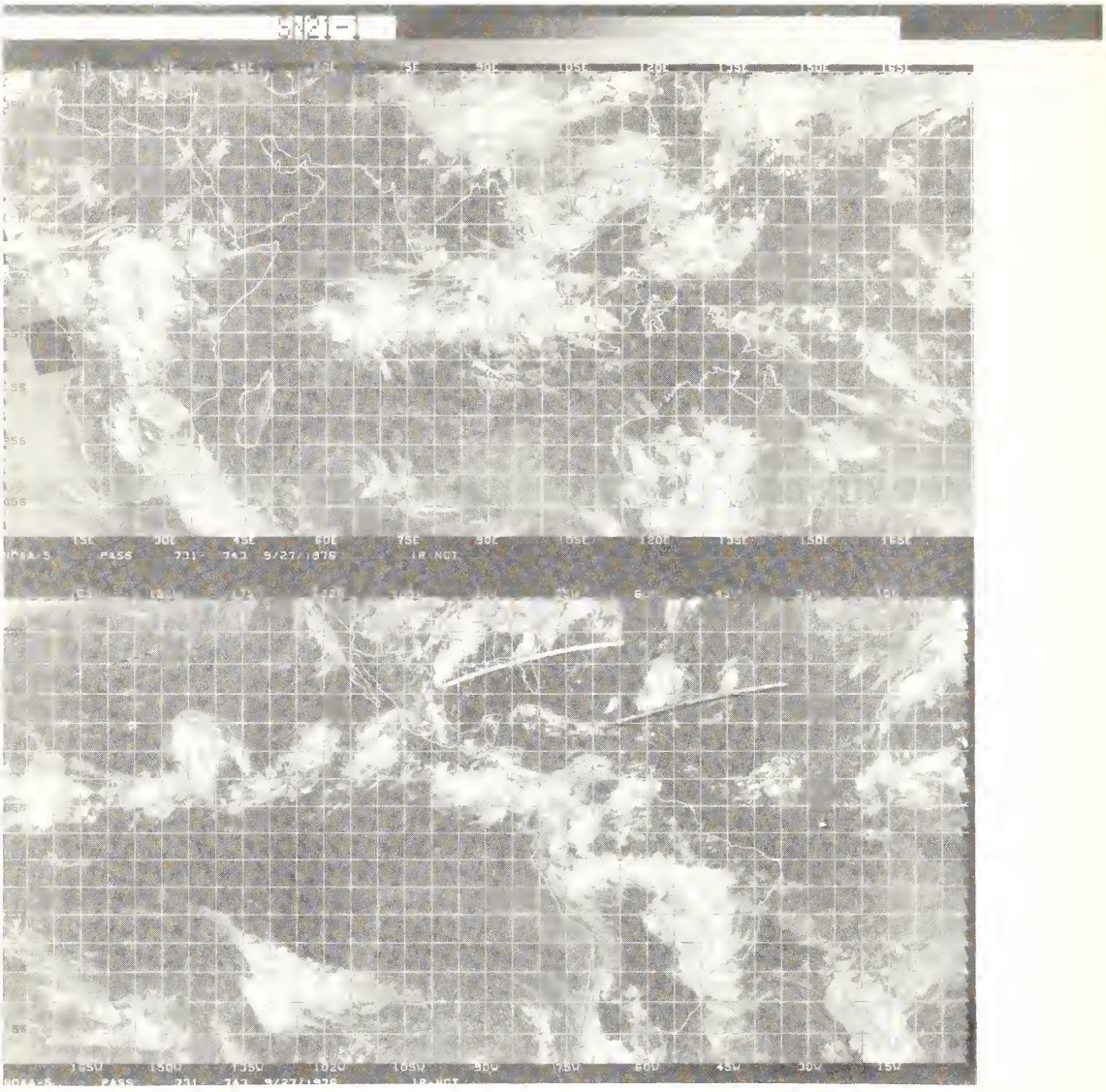

Figure 18.--Example of SR Mercator mosaic (infrared nighttime data).

e. Very High Resolution Radiometer (VHRR) Basic Images.

Description. The photographic display shown in figure 19 is produced from observations made by the VHRR sensor on board the polar-orbiting satellite. The VHRR senses in the visible and infrared channels with a resolution of about 1 km. High-resolution data collected by the satellite are either stored on board for later transmission as Very High Resolution Recorded (VREC) data or broadcast directly to ground stations as a High Resolution Picture Transmission (HRPT). For a description of the picture transmission capabilities of the polar-orbiting satellite, see NOAA Direct Readout.

Recorder capacity limits the amount of stored data to roughly 26° of latitude during each orbit. Areas recorded are selected at the request of qualified users. Each picture covers an area of approximately 2,100 by 2,100 km with usually two to three pictures available per pass. These displays are not stretched, gridded, or rectified.

After the data have been received from the satellite, the Command and Data Acquisition (CDA) station transmits them to Digital Muirhead Display (DMD) film recorders which produce 25-by-25-cm negative film transparencies. Negatives of all VHRR data received by NESS are archived by SDSB. A 90-day rotating archive of VHRR digital data on magnetic tape by SDSB began Jan. 1, 1977.

A legend appears at the bottom of the VHRR image providing a machine-produced gray scale for calibration and, immediately below from left to right, the station identification (e.g., San Francisco--SFO, Gilmore--GIL, and Wallops--WAL), time of year (day--ddd, hours--hh, minutes--mm, and seconds--ss) for first scan recorded, orbit (revolution) number (five digits), image data type (V--visible, I--infrared), image numbers (0, 1, 2, or 3) where 0 stands for special start scan, VHRR data direction (F--forward, B--backward), first line number transmitted (four digits), and operator's specified input parameters (20 characters).

The VHRR basic images are very useful in the construction of Great Lakes and Alaskan Ice Charts, Gulf Stream Wall Bulletins and Experimental Gulf Stream Analyses, West Coast Thermal Front Analyses, Basin Snow Coverage Observations, and Northern Hemispheric Snow and Ice Charts and for use in a variety of research work requiring high-resolution satellite data.

Primary users. This product has an extensive list of users inside and outside NESS, including NWS, ERL's, National Marine Fisheries Service, NASA, DOD, Arctic Institute, universities, and many foreign research and weather agencies.

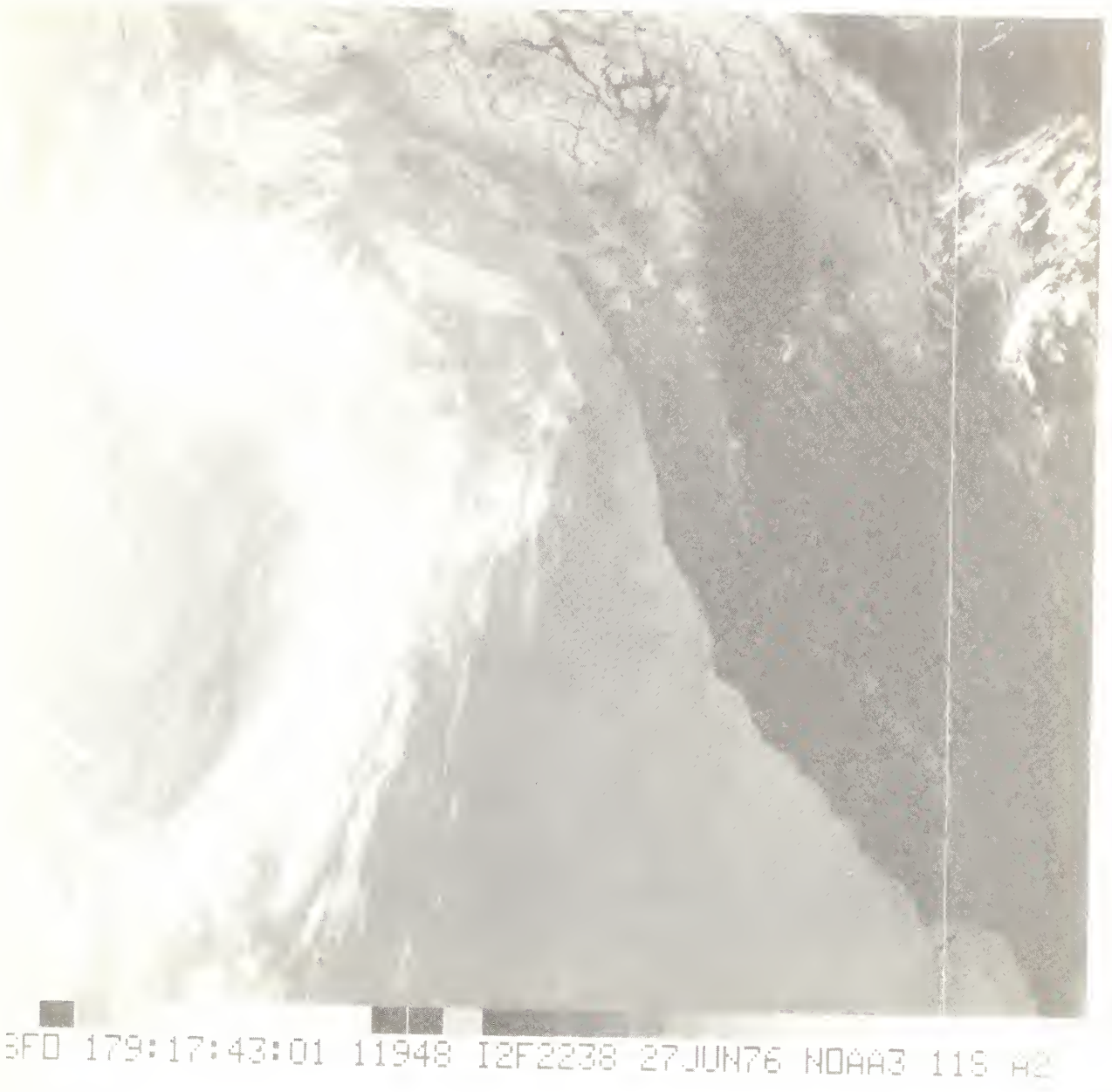

Figure 19.--Example of Very High Resolution Radiometer (VHRR) basic image.

f. Ten-Day Minimum Composite Brightness.

Description. The purpose of the minimum composite brightness chart is to minimize the effects of cloudiness in satellite-acquired SR data over polar regions. By saving only the minimum brightness response of each array location (512-by-512 array for each hemisphere) for a selected number of days, chart preparers can remove from the data set any relatively bright feature (clouds) that does not remain at one location for the 10-day period. The final product is recorded on tape and displayed as a photographic image (figure 20).

The legend that appears at the top of each hemisphere display provides the type of data (VIS or IR), hemisphere, and beginning and ending dates of the composite. A gray scale appears at the top of the print for film recorder calibration.

Ten-day composites are produced daily for the Northern and Southern Hemispheres with the latest 24 h added to the data set and the oldest 24 h deleted. This product is combined with other products to aid in differing areas of research and analysis. In locating permanent snowfields and icefields, the 10-day composite aids in the preparation of the Northern Hemisphere Snow and Ice Chart. Comparing the composite with other photographic displays, the analyst is able to separate the snowfield and icefield background from clouds. The 10-day composite also is helpful in terrain studies.

Primary users. Three groups within NESS currently are using these data--Environmental Sciences Group, Operational Products Monitoring Section, and Synoptic Analysis Section. These data are archived by SDSB.

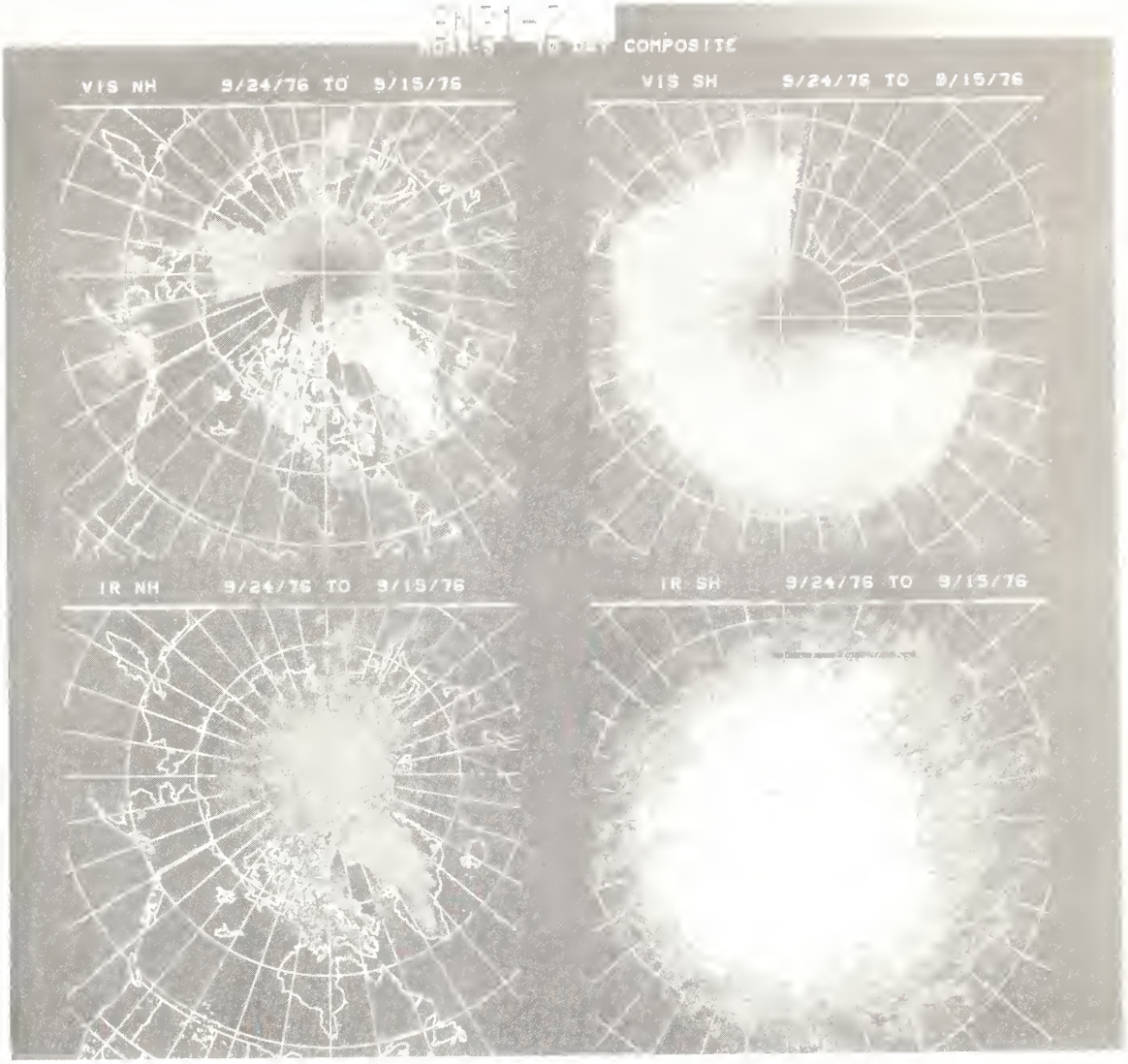

Figure 20.--Example of 10-day minimum composite brightness display.

2. ITOS/NOAA Facsimile Displays

Description. The data received from the SR sensor on board the polar-orbiting satellite are used in the computer-derived production of facsimile displays. These displays are in the form of mapped polar-stereographic and Mercator projects of a 1:30M and 1:120M resolution, respectively (figures 21 and 22). The gridding reveals the location of latitude and longitude lines, the outlines of land masses, satellite name, number of first pass used in the product, date (day/month/year) and time (GMT) of equator crossing, type of data (VIS, IR day, IR night), and NESS code name. The transmissions are sent on standard facsimile circuits at a rate of 120 lines per minute in 16 shades of gray. A list of facsimile products, the areas covered, and their time of transmission can be obtained from

NOAA/NWS, W534
8060 13th Street
Gramax Building
Silver Spring, Md. 20910

Facsimile displays find their usefulness in the determination of cloud cover, cloud-top heights, and type, structure, patterns, and behavior of specific circulation systems. When periods occur in which other data sources become unavailable, facsimile images can be used as a substitute. With the collection of a series of images, local scene changes can be observed revealing small-scale motions, convective activity, and diurnal and differential heating effects.

Primary users. Satellite facsimile displays are used by NWS, DOD, private meteorologists, universities, research concerns, and internally in NESS.

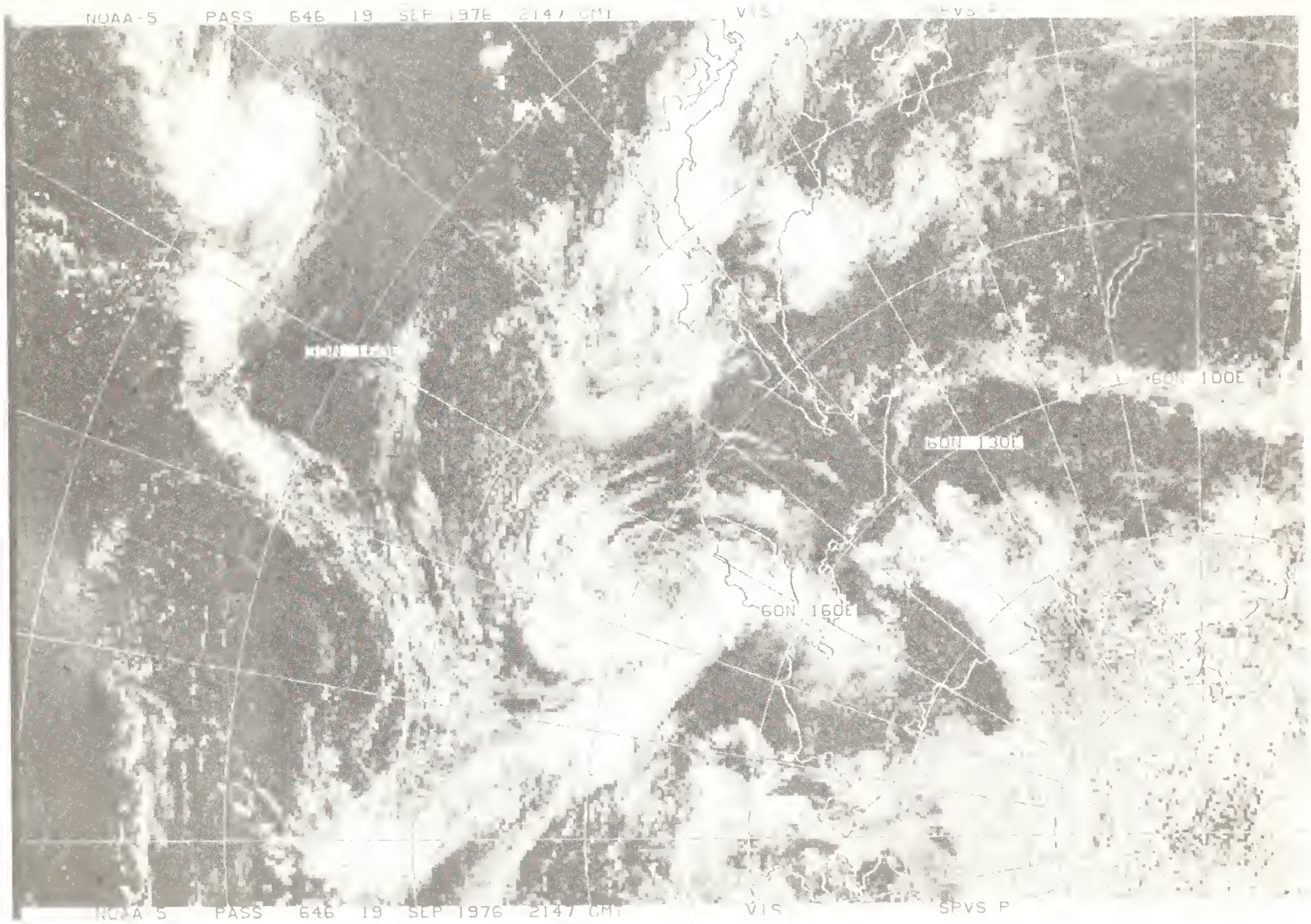

Figure 21.--Example of SR mapped polar-stereographic facsimile display.

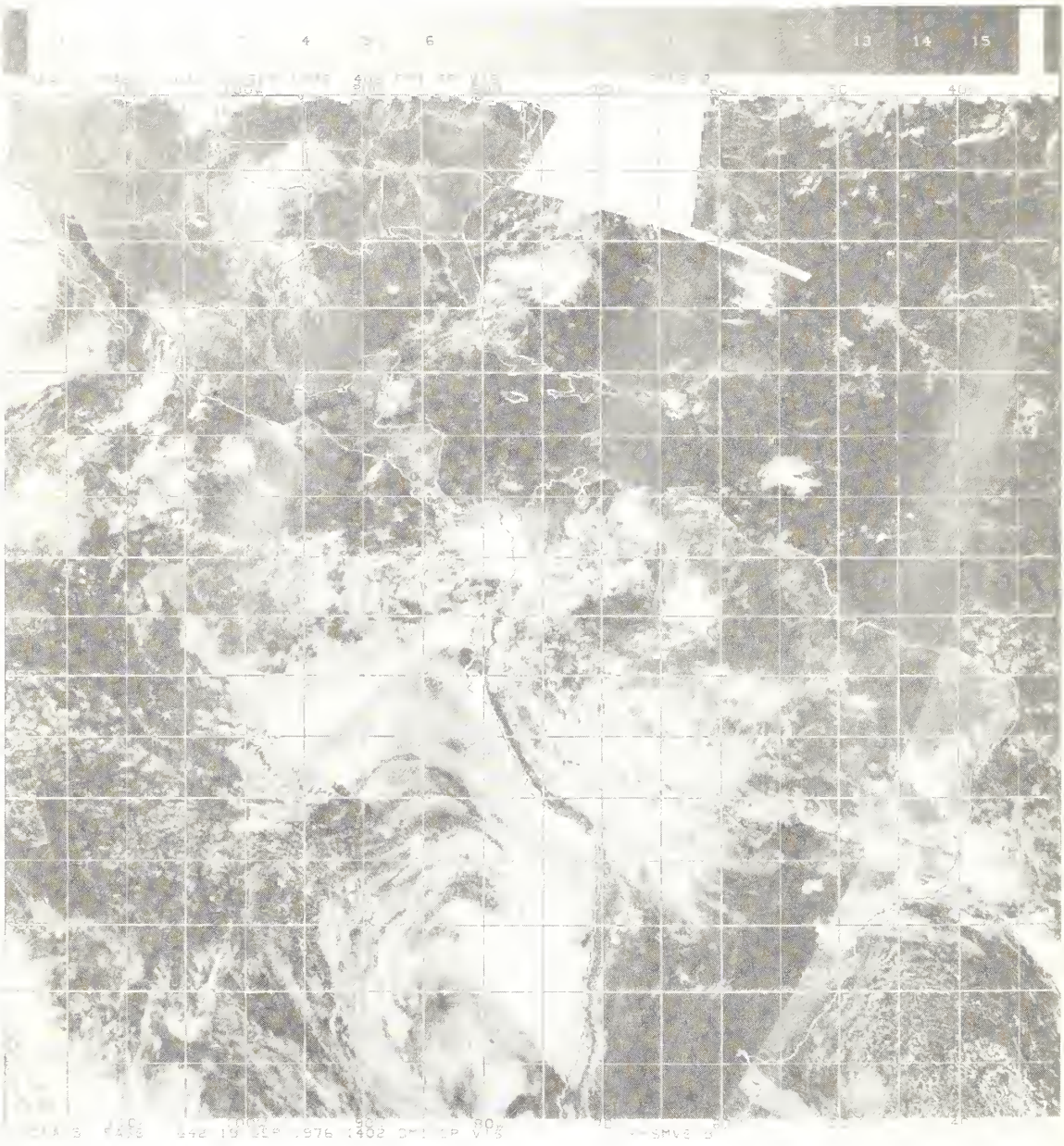

Figure 22.--Example of SR mapped Mercator facsimile display.

3. NOAA Direct Readout

Description. The NOAA polar-orbiting satellite continuously broadcasts its SR, VHRR, Vertical Temperature Profile Radiometer (VTPR), and Solar Proton Monitor (SPM), data to ground stations around the world. These stations receive from two to five or more broadcasts per day, depending on the latitude (the greater the amount, the higher the latitude) and capabilities of the receiving system. An example of VHRR data received by a station in Scotland, United Kingdom, is shown in figure 23.

NESS provides users with information on satellite tracking, data calibration, changes in transmitter status, and any other pertinent assistance that might affect the user's data reception. Requests for information on the planning, building, or modifying of a receiving station or on data utilization should be directed to

Coordinator, Direct Readout Services
DOC, NOAA, NESS
FB-4, S12x1
Washington, D.C. 20233

Primary users. Direct readout data are used by foreign and domestic government agencies, universities, commercial organizations, research concerns, and amateur ground station operators.

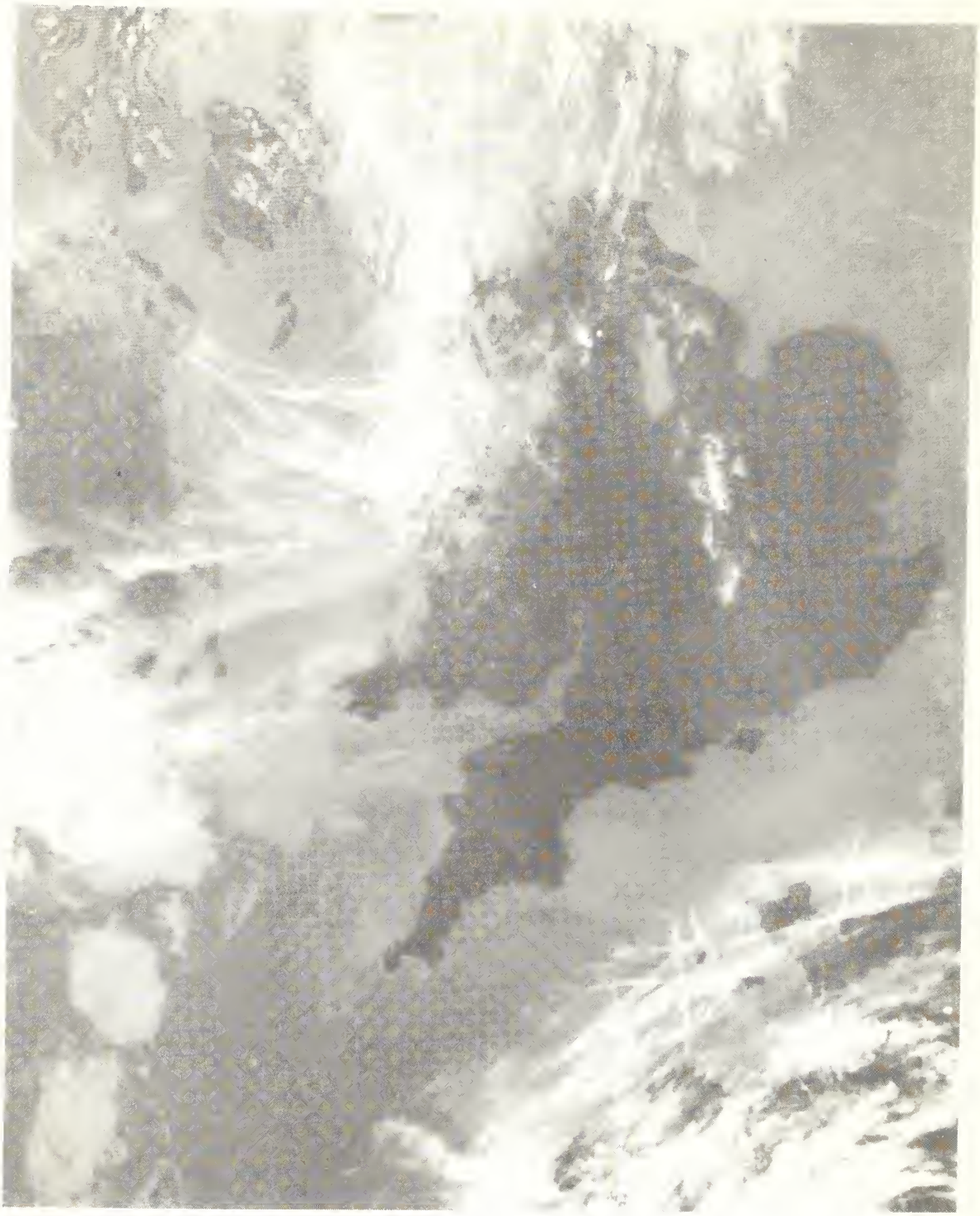

Figure 23.--Example of Very High Resolution Radiometer (VHRR) image received via direct readout in Scotland, United Kingdom.

II. METEOROLOGICAL SERVICES

A. Satellite Winds: Low-, Middle-, and High-Level Cloud Motion Vector Field Messages

Description. The process used to determine cloud motion vectors from geostationary satellite data involves three main steps: movie-loop generation, computer derivation of low-level winds, and man-machine derivation of middle- and high-level winds.

The movie loop is a 16-mm film consisting of five land-registered photographic images representing 2 h of real time, placed on a continuous loop with each image repeated twice and each beginning and end image repeated 20 times. The movie loop can then be projected on a digitizing board for the acquisition of beginning and end positions of clouds, thus obtaining cloud-motion vectors.

The low-level wind vectors are computer derived by ingesting four photographic images 30 min apart, selecting the best two images through a quality-control sequence, land-registering the images, cloud-target selecting at preselected offset 2.5° latitude/longitude locations, and wind-vector editing by comparison with the 850-mb analysis. This fully automated process produces the low-level vectors that are put through a final quality check by the meteorologist/analyst.

The middle- and high-level winds are derived through the use of the Man/Machine Interactive Processing System (MMIPS) (Bristor 1975). First, the movie loop is viewed by the meteorologist/analyst, cloud targets are chosen, and beginning and end positions are recorded. Next, the cloud targets are viewed on the MMIPS cathode ray tube (CRT), and temperatures are determined for each target chosen. The computer then compares cloud-target temperatures and vertical temperature profiles to obtain target heights and computes target velocity and direction of movement from the digitized movie-loop cloud-target movements. These data are put through a quality-control check with the 500- and 200-mb analyses.

The cloud-motion vector fields are produced at 00Z and 12Z and then delivered to users by 03Z and 15Z, respectively. The derived data are ingested into the National Meteorological Center's (NMC's) numerical forecast models, sent to users via teletype (figure 24), and archived on computer tapes by the Satellite Data Services Branch (SDSB).

Accuracy. Neither the satellite winds nor the radiosonde observations can be used as an absolute standard; however, the radiosonde is the best tool we have in determining the atmospheric winds. Therefore, the derived satellite winds are compared with radiosonde observations to determine their accuracy (Bauer 1976, Hubert and Timchalk 1972, Hubert 1976, Novak and Young 1976, Poole et al.(1975) unpublished, Poole and Borneman (1975) unpublished, Young et al. 1972).

For upper cloud vectors, Hubert (1976) determined that 68% deviated 15 kt or less from radiosondes, whereas lower cloud vector deviations were approximately half that of upper level deviations. He also states that "the accuracy of most cloud vector winds is about the same as that of balloon observations, but a small portion (say about 15 percent) contains significantly larger errors."

Primary users. NMC and various research concerns.

```
ZCZC 15Ø6
TWXN2Ø KXBC 29Ø9ØØ
SATWD GOES1 29Ø9
Ø2Ø61 3Ø111 3Ø548
Ø1251 3Ø111 31Ø24
ØØ318 3Ø111 Ø6531
ØØ218 3Ø111 Ø6527
ØØ119 3Ø111 Ø5534
Ø11Ø7 3Ø111 1Ø535
Ø13Ø7 3Ø111 12Ø36
```

CODE FORMAT

TWXii KWBC YYGGgg

SATWO NAME YYGG

QLaLaLoLo PcPcSnTcTc ddfff

TW Data designator--satellite wind.

XX Geographical designators: XN, Northern Hemisphere; XS, Southern Hemisphere; XX, unspecified area.

ii First i: number of the bulletin.
Second i: number of global octant.

Northern Hemisphere	Southern Hemisphere
0--0 to 90 W.	5--0 to 90 W.
1--90 W. to 180.	6--90 W. to 180
2--180 to 90 E.	7--180 to 90 E.
3--0 to 90 E.	8--0 to 90 E.

KWBC Location indicator of originating office.

YYGGgg Date-time group; GGgg--approximate time of observation (in GMT).

SATWD Data identifier for satellite winds.

NAME The commonly known name of the satellite.

Q Octant of the globe.

LaLa Latitude to nearest whole degree.

LoLo Longitude to nearest whole degree.

PcPc Derived pressure level (in centibars) of cloud vectors.

Sn Sign of temperature value ("1" = "-"; "0" = "+").

TcTc Temperature of cloud in degrees Celsius.

dd Wind direction in tens of degrees.

ff Wind speed in whole knots.

Other symbolic letters are used with their international specifications.

Notes on the use of the code form:

1. Cloud temperatures are estimated from infrared observations of cloud fields; these temperatures correspond to the atmospheric temperature at the elevation where the ambient wind matches the cloud motion.
2. Cloud temperatures for low levels are not given.
3. If temperature data are not available (hence no derived pressure) for middle and high levels, the temperature data are omitted and estimated pressures are transmitted.
4. A complete set of the QLaLaLoLo PcPcSnTcTc ddfff is required for each wind report.

Figure 24.--Example of a coded low-, middle-, and high-level cloud-motion vector field message (top) and a description of the code format (bottom).

B. Atmospheric Soundings: Vertical Temperature Profile Radiometer (VTPR) Soundings

Description. VTPR data are currently being used to produce operational atmospheric profiles of temperature and humidity on a global scale. The polar-orbiting satellites produce global coverage (figure 25) twice daily with profiles valid at 0000 GMT and 1200 GMT for open-water ocean areas. These soundings are useful as input into forecasting models and research projects because of the scarcity of data over the oceans.

The VTPR continuously scans perpendicular to the satellite motion in 23 discrete steps. It records data in eight spectral channels at each step. Six of the eight channels sense radiances in the 15-μm carbon dioxide band, while the other two channels sense in a water absorption band (18.7 μm) and in an atmospheric window (11.9 μm). A description of the VTPR instrument, its calibration, procedures used to obtain "clear radiances" from cloud-contaminated radiance measurements, retrieval techniques used to obtain temperature and humidity profiles from the resulting "clear radiances," and quality checks performed on the data can be found in McGinnis et al. (1975). This process results in the generation of three magnetic tapes. One tape is used to send a teletype message, a second is sent to NMC, and a third is prepared as a data archive for deposit at the SDSB located in the World Weather Building, Camp Springs, Md. 20233.

Accuracy. The accuracy of VTPR data is checked against radiosonde data. For mandatory levels in the atmosphere above 1,000 mb the accuracy is ±2-4° C and for mean layer temperature is ±1-2° C. The reliability of dew-point depression observations, at mandatory levels, has not been established; therefore, no accuracy checks are available. A monthly list of current accuracies is supplied to users.

Primary users. NMC, U.S. Navy, foreign weather operations, and various research projects use this product.

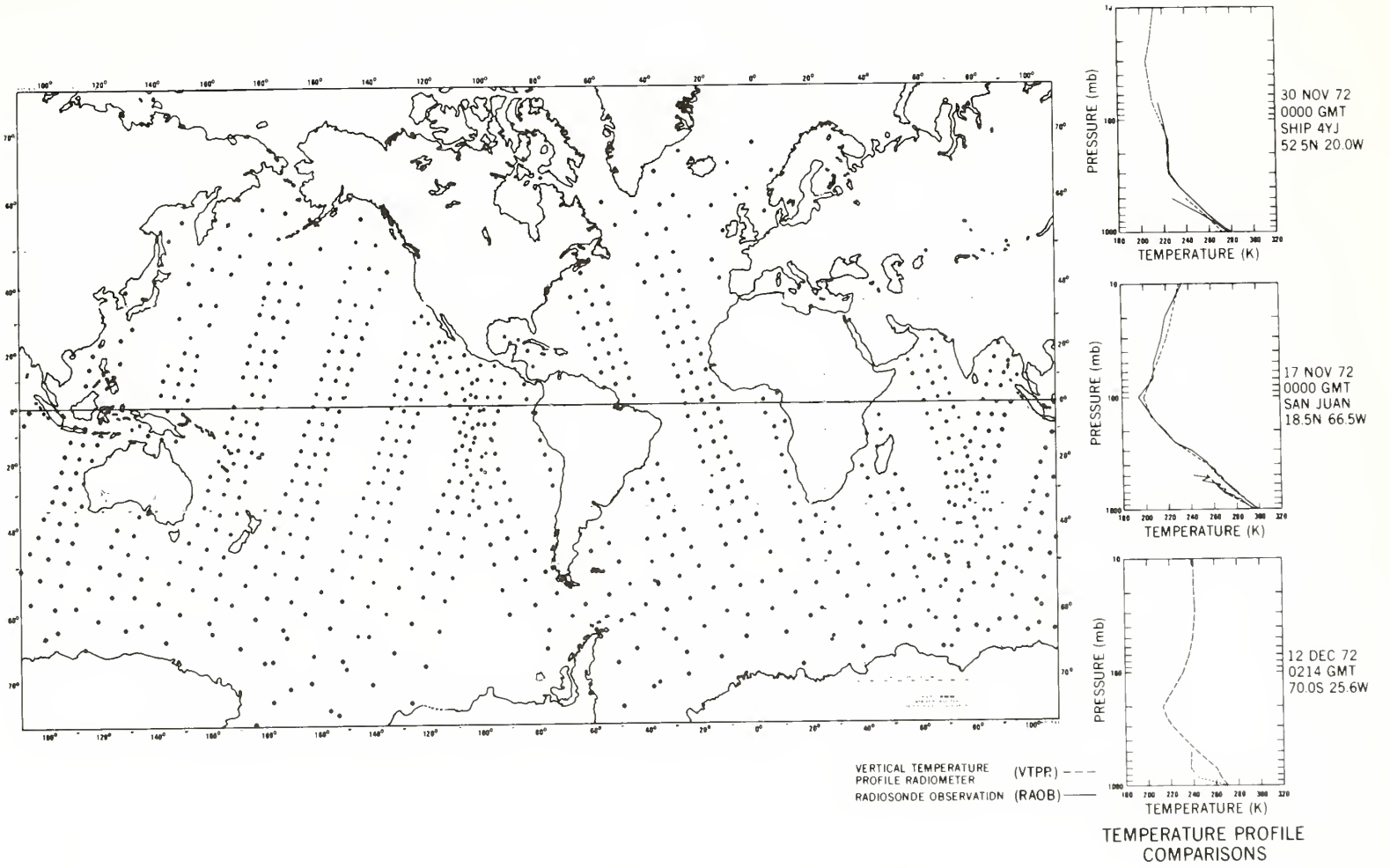

Figure 25.--Approximate locations of VTPR soundings.

C. Weather Summary and Bulletins

1. Satellite Interpretation Message

Originator. Satellite Field Service Stations.

Description. The Satellite Interpretation Message (figure 26) is a general synopsis of the weather affecting the United States supplied two to eight times per day depending on the issuing office. The summary is sent out via teletype to all users.

Primary users. This product is received by most domestic weather operations.

U.S. VIEW FROM 7PM EDT JULY 3 TO 7AM EDT JULY 4
OVER THE EASTERN UNITED STATES THUNDERSTORMS ARE PRESENT ALONG A COLD FRONT MOVING SLOWLY SOUTHEASTWARD THROUGH THE MIDDLE ATLANTIC STATES AND NORTHERN OHIO VALLEY. ONE AREA OF THUNDERSTORMS MOVES OFF THE DELMARVA PENINSULA AFTER CAUSING ONE TORNADO NEAR BALTIMORE YESTERDAY. NEW THUNDERSTORMS FORM DURING THE NIGHT FROM ILLINOIS TO OHIO AND DRENCH DAYTON, OHIO WITH AN ADDITIONAL INCH OF RAIN FOLLOWING A NEARLY FOUR INCH RAINFALL TOTAL YESTERDAY.

ALONG THE WESTERN GULF COAST THUNDERSTORMS ARE SEEN WEAKENING DURING THE NIGHT WHERE THE HIGH THIN CLOUDS FROM THE THUNDERSTORM TOPS BLOW OFF IN A LARGE COUNTERCLOCKWISE PATTERN: EVIDENCE OF THE WEAK UPPER LOW OVER THAT AREA.

THE ROCKY MOUNTAIN STATES RECEIVE SIGNIFICANT RAINFALL AMOUNTS FROM THE THUNDERSTORMS THAT REACH A MAXIMUM INTENSITY SHORTLY AFTER THE BEGINNING OF THE MOVIE THEN WEAKEN SLOWLY DURING THE NIGHT. BILLINGS, MONTANA AND SURROUNDING AREAS RECEIVED UP TO THREE INCHES OF RAIN OVERNIGHT NECESSITATING FLASH FLOOD WARNINGS IN SOME SECTIONS OF SOUTHEAST MONTANA.

THE WEST COAST STATES ARE MOSTLY CLEAR EXCEPT FOR HIGH THIN CLOUDS RAPIDLY CIRCLING AN UPPER LOW JUST OFF THE NORTHERN CALIFORNIA COAST AND SOME LOW CONTRAST BETWEEN THE TOPS OF THE WARM CLOUDS AND THE GROUND SURFACE.

EASTERN U.S. VIEW FROM 9:30AM EDT TO NOON JULY 4
ONE AREA OF THUNDERSTORMS HAS CONTINUED SOUTHEASTWARD INTO THE MIDDLE ATLANTIC STATES WITH A NEW LINE OF THUNDERSTORMS FORMING OVER THE LOWER OHIO VALLEY. SHOWER CLOUDS HAVE FORMED IN THE MIDDLE ST. LAWRENCE VALLEY AND ARE MOVING INTO EXTREME NORTHERN NEW ENGLAND.

WESTERN U.S. VIEW FROM 9:30AM EDT TO NOON EDT JULY 4
A FEW NEW THUNDERSTORMS ARE FORMING OVER THE TEXAS PANHANDLE, ARIZONA AND MONTANA. HIGH THIN CLOUDS CONTINUE TO MOVE RAPIDLY COUNTERCLOCKWISE AROUND THE LARGE UPPER LOW OFF THE CALIFORNIA COAST.

Figure 26.--Example of Satellite Interpretation Message.

2. Satellite Weather Bulletin

Description. Satellite Weather Bulletins are coded messages describing past (12 and 24 h previous) and present location, movement, intensity (using Dvorak Tropical Disturbance Classifications), and general cloud characteristics of tropical cyclones. Meteorologists routinely analyze and interpret polar-orbiting and geostationary satellite data images over all ocean areas for potential and existing tropical disturbances and prepare bulletins to be sent out as needed via teletype (figure 27). The bulletins are useful in alerting domestic and foreign weather operations to significant tropical weather due to the lack of conventional weather observations over the oceans.

Accuracy. The accuracy in location and movement is dependent on the resolution of the satellite imagery used. This accuracy of positioning is ±6 n.mi. (±11 km).

Primary users. The product is used by domestic and foreign weather operations.

SATELLITE WEATHER BULLETIN

NOAA-4 VIS/IRDAY WEST PACIFIC
RUBY
01 JULY 1976 0022Z
23N 126.1E T5.5/5.5/DO.5/24HRS

PAST POSITIONS: E21.2N 124E 301209Z IRNITE
21.1N 122.9E 300123Z VIS/IRDAY

CENTER DEFINED BY ROUND DISTINCT EYE APPROX ONE-THIRD DEG DIA.

PLEASE ACK
SGD/NOAA-NESS

ABXX 13 KWBC
SATELLITE TROPICAL DISTURBANCE SUMMARY
ALL MOVEMENTS AND TRENDS 24 HRS UNLESS OTHERWISE STATED

WEST PACIFIC NOAA 4 VIS/IRDAY 302000-010200Z

23N 126.1E 0022Z T5.5/5.5/DO.5/24HRS RUBY
27.2N 142.3E 2226Z T4.5/4.5MINUS/SO.0/24HRS SALLY

BRKN BAND MOD ACTIVE CONV DEVELOPED FROM YDA EXTENDS 9N 144E to EQ. 140E to eq. 135E DEG WIDE. WIDELY SCTD BAND MOD ACTIVE CONV WEAKER THAN YDA EXTENDS 4N 180W to 5N 170E to 13N 160E 1 DEG WIDE.

SOUTH PACIFIC NOAA 4 VIS/IRDAY 301500-323002

SCTD BAND MOD ACTIVE CONV SAME AS YDA EXTENDS 10S 150E to 12S 160E 2 DEG WIDE. SCTD AREA MOD ACTIVE CONV SAME AS YDA 5-7S FROM 147E to 156E. BRKN AREA MOD ACTIVE CONV DEVELOPED FROM YDA CENTERED 20S 170E 2 DEG DIA.

7/1 0530 A

Figure 27.--Example of Satellite Weather Bulletin .

3. Tropical Disturbance Summary

Description. The Tropical Disturbance Summary (figure 28) is a coded message listing all Satellite Weather Bulletins sent during the previous 24 h and the locations of all vortices with a tropical history, significant disturbed areas, and the Intertropical Convergence Zone (ITCZ). Two summaries are sent out via teletype per day for each ocean area covered. These areas are the Atlantic and East Pacific (to 180° W), West and South Pacific, and the Indian Ocean. The summaries are prepared by meteorologists using visible and infrared satellite imagery from both the polar-orbiting and geostationary satellites. With the reception of these summaries, the coastal and marine areas of the globe can keep a watchful eye on significant tropical weather situations.

Accuracy. Due to the summary being a synoptic-scale discussion, the accuracy of locations and movements is to the nearest degree of longitude or latitude (±30 n.mi. or ±56 km).

Primary users. The product is used by domestic and foreign weather operations.

ABXX 16 KWBC

SATELLITE TROPICAL DISTURBANCE SUMMARY

ALL MOVEMENTS AND TRENDS 24 HRS UNLESS OTHERWISE STATED

CENTRAL AND WEST PACIFIC NOAA-4 IRNITE 270543Z TO 271330Z

BRKN MODERATELY ACTIVE TO ACTIVE ITCZ HAS INCREASED IN INTENSITY...
ITCZ 3 TO 4 DEG WIDE BEGINNING IN EAST PACIFIC FROM 9N 140W TO 5N
155W TO 6N 177W TO 4N 168E.
MODERATELY ACTIVE CONVECTIVE AREA THAT HAS WEAKENED AND MOVED 4 DEG
TO THE WEST...5 DEG DIAMETER CENTERED 13N 131E.
BRKN MODERATELY ACTIVE CONVECTIVE AREA THAT HAS INCREASED IN ACTI-
VITY PAST 12 HRS...5N TO 19N BETWEEN 120E AND 126E.
BRKN ACTIVE CONVECTIVE AREA BOUND BY 20N 160E TO 18N 172E TO 33N
175E TO 20N 160E...HAS EXHIBITED LITTLE MOVMNT AND CHANGE.
VORTEX DESCRIBED BY UPPER CLOUDS AT 34N 164E.

NO TROPICAL CYCLONE ACTIVITY NOTED.

SOUTH PACIFIC NOAA-4 IRNITE 270340Z TO 271127Z

BRKN MODERATELY ACTIVE CONVECTIVE AREA THAT HAS SHOWN LITTLE CHANGE...
BOUND BY 2N 158E TO 10S 160E TO 1N 135E TO 2N 158E.

NO TROPICAL CYCLONE ACTIVITY NOTED.

Figure 28.--Example of Satellite Tropical Disturbance Summary.

D. NMC Support

1. Two-Layer Moisture Analysis

Description. The Two-Layer Moisture Analysis is a chart (figure 29) prepared by National Environmental Satellite Service (NESS) analysts showing the Mean Relative Humidity (MRH) over the eastern North Pacific Ocean, western North Atlantic Ocean, and the Gulf of Mexico. An eight-scale MRH contour is determined for the 1,000- to 700-mb and the 700- to 500-mb layers of the atmosphere by manually viewing geostationary and polar-orbiting satellite imagery and VTPR data. These data are plotted on a 30-by-40-cm, 1:20M base map and compared with the 12-h Primitive Equation (PE) moisture prognosis for adjustment of the computer-derived relative humidities. The correctional data (bogus values) are punched on cards and read into the computer for an update to the 00Z and 12Z NMC moisture analysis and the Quantitative Precipitation Forecasts (QPF) of precipitable water and precipitation.

Accuracy. The moisture analysis is compared with radiosonde data to determine by statistical analysis and graphs how well the bogus values helped the moisture analyses and QPF. When the line curves of the satellite soundings and Radiosonde Observation (RAOB) differ greatly, steps are taken to implement better bogusing.

Primary users. The users of the two-layer moisture analysis are the NMC divisions of Basic Weather Branch and Quantitative Precipitation Branch.

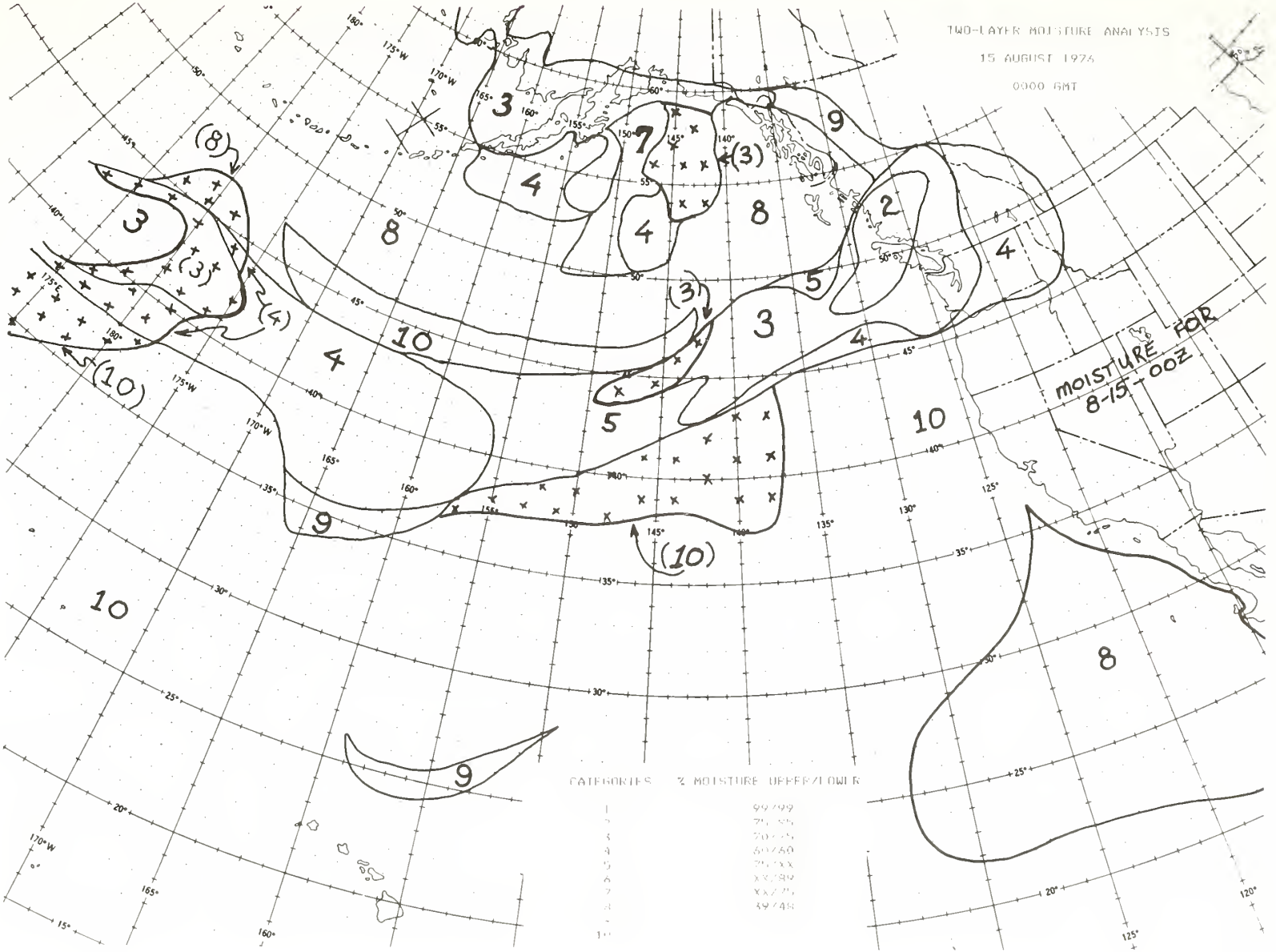

Figure 29.--Example of a two-layer moisture analysis.

2. Satellite Input to Numerical Analysis and Prediction (SINAP)

Description. The SINAP program involves the melding of satellite-observed cloud patterns with the 12-h global forecasted 300-mb height field. This is done over the areas of the North Atlantic Ocean and North Pacific Ocean for the 00Z and 12Z analyses. Because of the lack of sufficient data in the analyses, short wavelength features are often omitted from the global first guess in these ocean areas.

To perform this program, the analyst views satellite imagery from the geostationary satellites in both hard-copy (photo display) and movie-loop form. In addition, a data plot consisting of raw radiances, satellite-derived winds, and VTPR 300-mb heights is available. From these, a 1:20M polar-stereographic projection is drawn (figure 30) with positions of troughs, ridges, and vortices that represent a more detailed contour analysis than the global 12-h forecast. This analysis is given to the Aviation Weather Branch of NMC, along with a brief on satellite global field differences before the final 300-mb analysis is made.

Primary users. This product is used primarily by the Aviation Weather Branch of NMC.

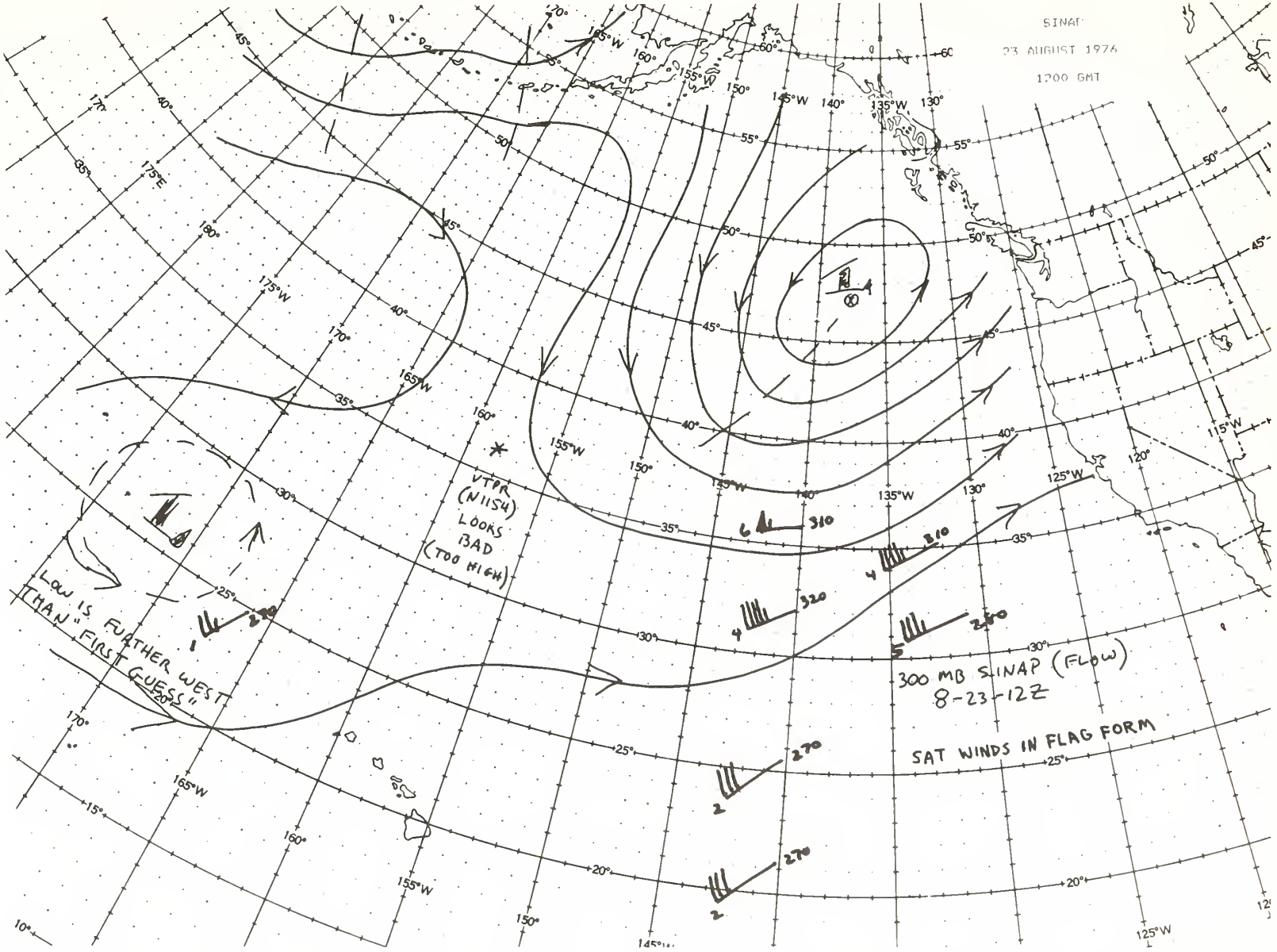
SINAP
23 AUGUST 1976
1200 GMT
VTPR (N11SW) LOOKS BAD (TOO HIGH)
LOW IS FURTHER WEST THAN "FIRST GUESS"
300 MB SINAP (FLOW) 8-23-12Z
SAT WINDS IN FLAG FORM

Figure 30.--Example of a Satellite Input to Numerical Analysis and Prediction (SINAP) chart.

E. Miscellaneous

1. Briefings and Advisory Support

Description. During a normal day at NESS, several briefings and advisory communications take place among its members--between NESS and the personnel of NMC and various concerns dependent on satellite data.

At 8:30 A.M. local time, the members of the Applications Group meet together for a briefing on the weather that has occurred over the previous 24 h. Several movie loops are viewed with the emphasis being placed on the applications of satellite meteorology to the field of meteorology as a whole. At 3:30 P.M. the personnel of the Meteorological Satellite Laboratory meet for an informal viewing of movie loops of the previous day's weather. This time is used for people to keep current with weather situations and form new ideas for research and modeling. Anyone interested can attend.

At various times during the day, the Synoptic Analysis Section is in contact with the Satellite Field Service Stations (SFSS's). This takes place via telecopiers enabling the people at NESS central to keep the field service stations informed of any new developments with current weather, program changes, etc., and vice versa.

The meteorologists in NMC are briefed on current satellite data in order to supplement the numerical forecasts and conventionally observed data that are available. The NESS briefer uses analyzed charts, movie loops, and satellite photographic images to inform the NMC forecaster of current weather conditions as seen from the polar-orbiting and geostationary satellites.

Many communications not listed here take place in NESS constituting a continuous support to the people dependent on satellite data.

2. Training Aids

Description. The Applications Group of NESS provides training aids to the NWS forecast offices, World Meteorological Organization (WMO), and various universities in its effort to keep these organizations informed of all the latest applications and findings in using satellite data for forecasting and research. These aids are in the form of training films, video tapes, slide lectures, and workshops. Inquiries for these aids can be made to the Planning and Coordination Group of NESS. The Applications Group also puts together a routine publication, entitled Satellite Applications Information Notes, that is scheduled for press three times each month. Internally in the National Oceanic and Atmospheric Administration (NOAA), these notes are distributed through the Activities Report; externally, by the Meteorological Satellite Laboratory list.

3. Automatic Picture Transmission Information Note

Description. The Direct Readout user community is supplied with any useful information that might affect their operations in the form of an APT Information Note sent out by mail periodically, i.e., as the need arises. These information notes contain news of planned satellite launches, operating schedules, sensors, products, and other pertinent information. They are particularly useful to anyone planning to build or operate ground equipment capable of receiving Automatic Picture Transmission (APT), High Resolution Picture Transmission (HRPT), Weather Facsimile (WEFAX) Network, Visible Infrared Spin Scan Radiometer (VISSR), or DSB data.

APT Information Notes can be obtained from

Coordinator, Direct Readout Services, S12X1
U.S. DOC, NOAA, NESS, FB-4
Suitland, Md. 20233

III. OCEANOGRAPHIC SERVICES

A. Sea Surface Temperature (SST) Products

1. Global Operational SST Observations

Description. Global sea surface temperature observations (Brower et al. 1976) are obtained daily from the polar-orbiting satellite's scanning infrared radiometer. The model used in obtaining these temperatures is the fully automated computer procedure GOSSTCOMP (Global Operational Sea Surface Temperature Computation). The surface temperature observations are derived by a histogram technique applied to 1,024 instrument measurements with partially overlapping fields of view in roughly a 100-km^2 area surrounding the retrieval point. Correction for atmospheric attenuation in the infrared sensor's 10.5μm to 12.5μm spectral window is computed from the Vertical Temperature Profile Radiometer (VTPR) and applied to the temperature retrievals. The model generates 8,000 to 10,000 time- and earth-located values of sea surface temperatures daily. The derived observations are stored on computer disk for National Oceanic and Atmospheric Administration (NOAA) 360/195 terminal users, entered onto a magnetic tape for the archive at the Satellite Data Services Branch (SDSB), and used to produce an observation transmission tape, when required, and a global analyzed field.

The global analyzed field is used to produce two types of products: photographic displays and gridded fields.

The photographic displays (figure 31) produced from the GOSSTCOMP program enable the user to view the global SST pattern and the spatial distribution of observations used in the analysis. The left-hand display presents the sea surface temperatures in an 11-step gray scale from 302 K to 270 K in 3-degree intervals. The right-hand portion displays the number of observations used in the analysis of each grid point with a gray scale running from 0 (white) to 10 or more (darkest gray). All previous 24 h of data and the date of the analysis appear in the lower right-hand corner.

The gridded fields (figure 32) are contoured 50-by-50-degree displays of sea surface temperatures in intervals of 1° C. They are available as Mercator projections from 50° N to 50° S latitude and in polar-stereographic projections for the remainder of the globe. The gridded fields are mailed to users once a week.

The SST data are used in numerical forecast models, as support for other National Environmental Satellite Service (NESS) products, in development of climatology over ocean areas that are inexcessible by conventional observing methods, and by various research concerns.

Accuracy. The accuracy of both GOSSTCOMP observations and the gridded analyses is checked twice daily by comparison with ship observations. The obtained observational accuracy is within ±1.5° C of ship observations (Bristor 1975, Brower et al. 1976).

Primary users. The primary users of SST data are the National Weather Service (NWS), oceanographic services, environmental research concerns, and commercial fisheries. The data are archived by the SDSB.

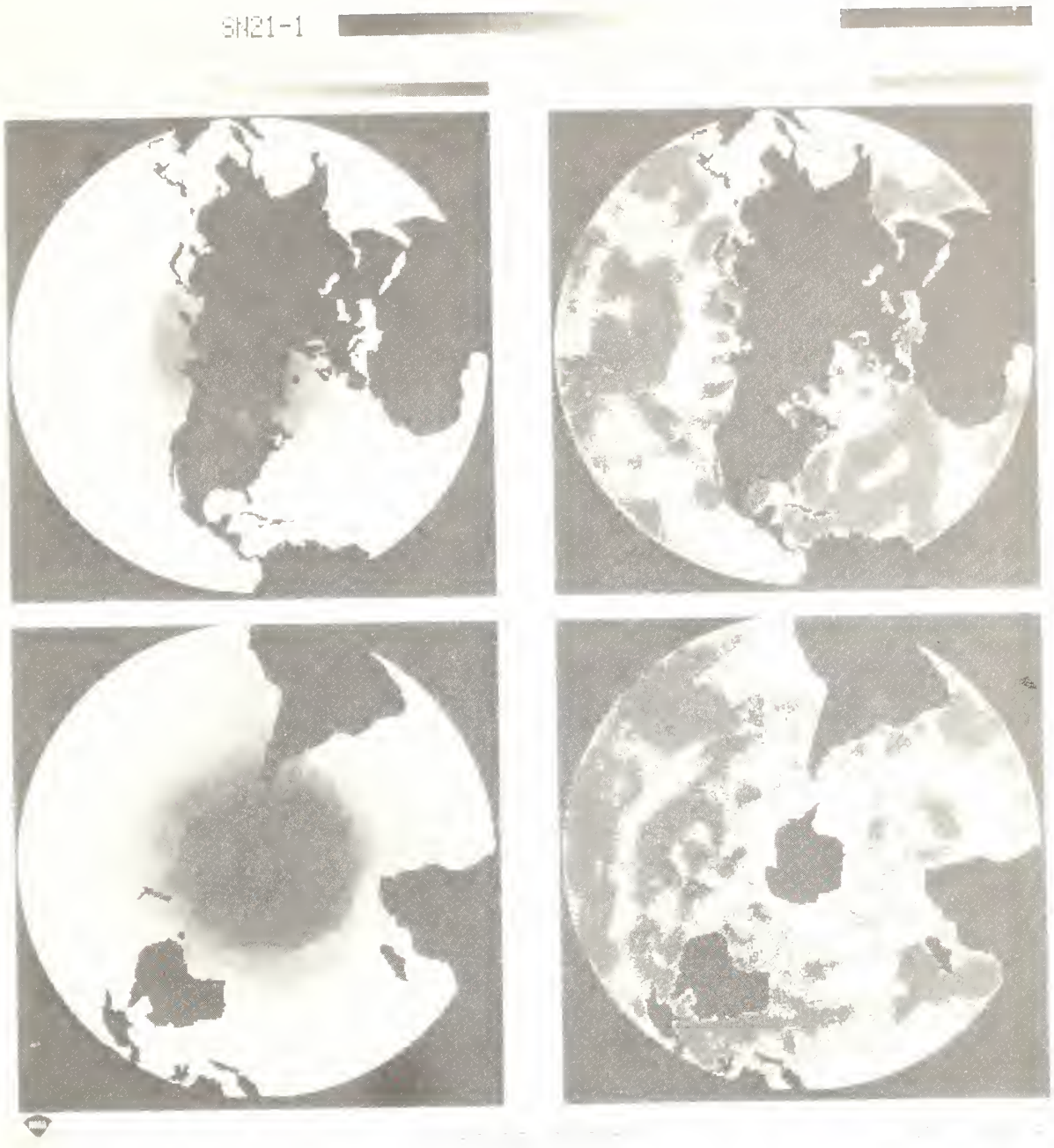

Figure 31.--Example of GOSSTCOMP "quick look" photographic display of sea surface temperatures and spatial distribution of observations.

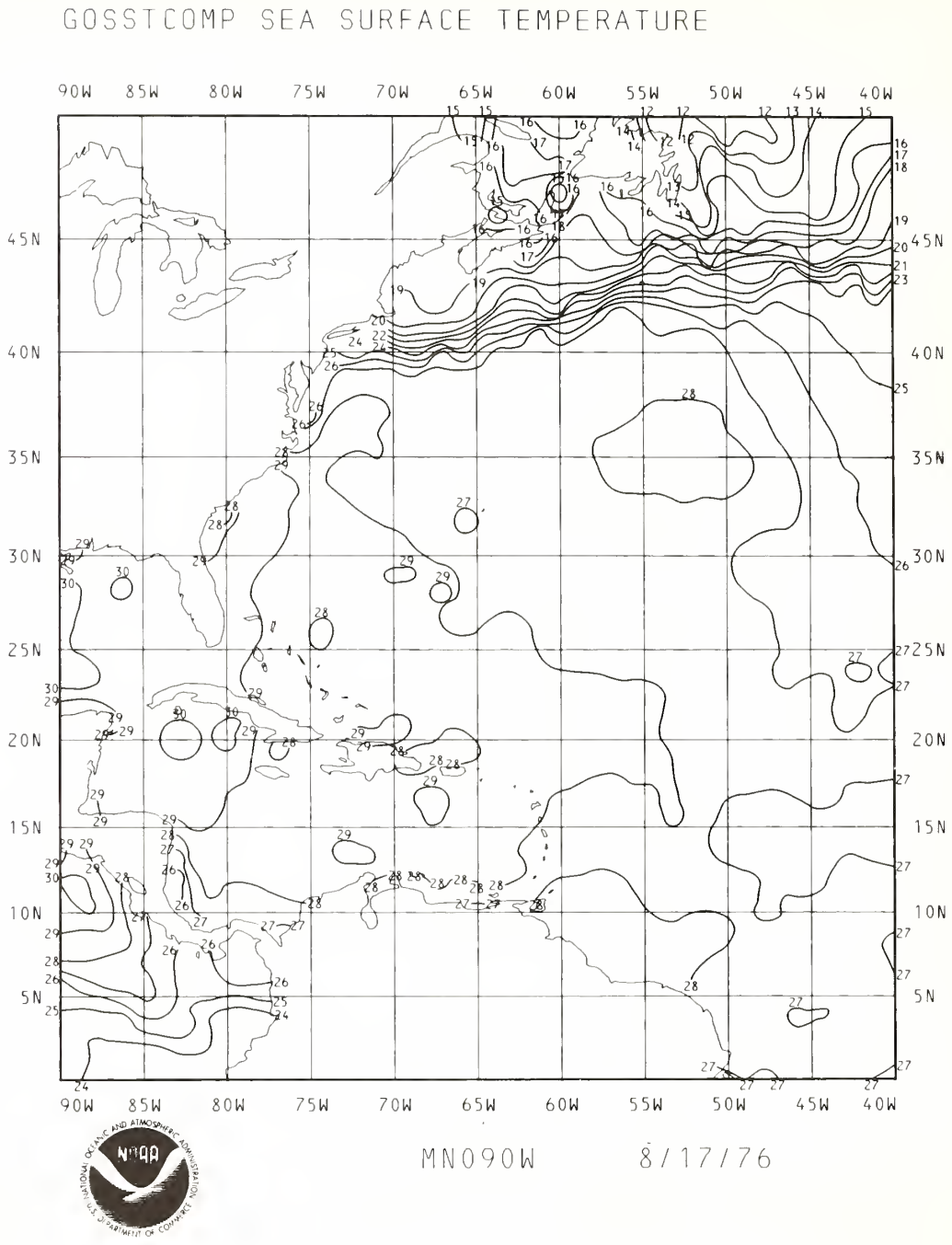

Figure 32.--Example of GOSSTCOMP gridded analysis of sea surface temperatures.

2. Great Lakes Surface Temperature Analysis

Description. Analyses of the Great Lakes surface temperatures (Strong 1974) are produced as observed (whenever cloud free) from the data obtained from the polar-orbiting satellite's Very High Resolution Radiometer (VHRR). The data are computer analyzed for each of the five Great Lakes, with a contour interval of 2° C. The final product (figure 33) is then manually adjusted for accuracy and mailed to users.

The surface temperature analyses are useful in determining the rate of lake freeze and areas of upwelling. With this knowledge plus observed weather and ice-observed conditions, a forecast can be made for the routing of ships and in predicting the length of the shipping season.

Accuracy. This product has been checked, using 1 yr of ship observations to determine its accuracy. The surface temperature analysis can experience an overall bias of ±2° C absolute. The accuracy of the sensor in observing temperature is ±1° C relative. Observations are limited to cloud-free situations.

Primary users. The Great Lakes surface temperature analysis is used by NWS, commercial marine transportation , Great Lakes research concerns, and internally in NESS.

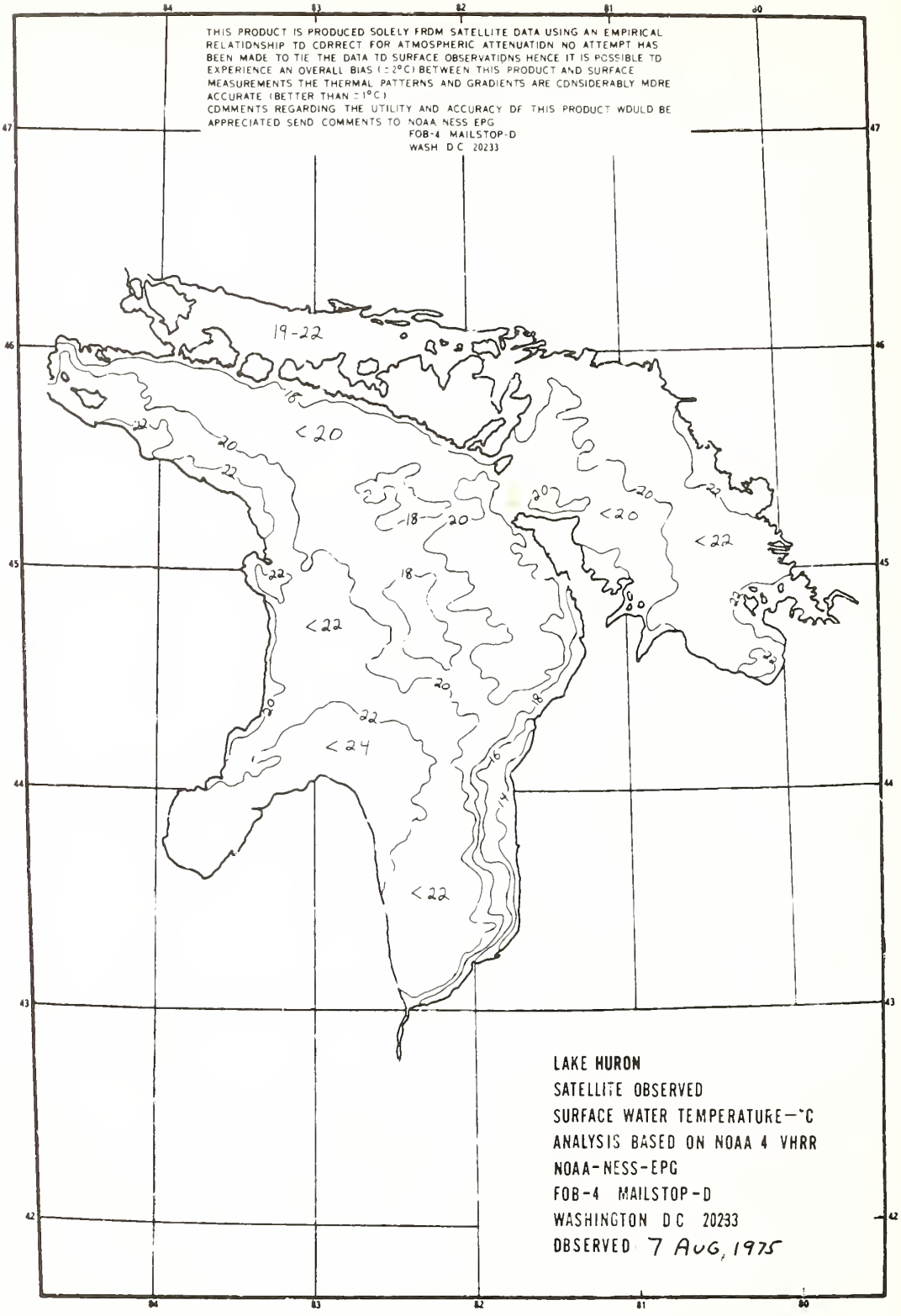
THIS PRODUCT IS PRODUCED SOLELY FROM SATELLITE DATA USING AN EMPIRICAL RELATIONSHIP TO CORRECT FOR ATMOSPHERIC ATTENUATION NO ATTEMPT HAS BEEN MADE TO TIE THE DATA TO SURFACE OBSERVATIONS HENCE IT IS POSSIBLE TO EXPERIENCE AN OVERALL BIAS (±2°C) BETWEEN THIS PRODUCT AND SURFACE MEASUREMENTS THE THERMAL PATTERNS AND GRADIENTS ARE CONSIDERABLY MORE ACCURATE (BETTER THAN ±1°C)
COMMENTS REGARDING THE UTILITY AND ACCURACY OF THIS PRODUCT WOULD BE APPRECIATED SEND COMMENTS TO NOAA NESS EPG
FOB-4 MAILSTOP-D
WASH D.C 20233
19-22
<20
<22
<24
LAKE HURON
SATELLITE OBSERVED
SURFACE WATER TEMPERATURE—°C
ANALYSIS BASED ON NOAA 4 VHRR
NOAA-NESS-EPG
FOB-4 MAILSTOP-D
WASHINGTON D C 20233
OBSERVED 7 AUG, 1975

Figure 33.--Example of Great Lakes surface temperature analysis of Lake Huron.

B. Ice Charts and Ocean Current Analyses

1. Great Lakes and Alaskan Ice Charts

Description. The Great Lakes and Alaskan ice charts are detailed 1-km resolution analyses of the boundaries and type or age of ice observed from satellite photographic imagery.

The Great Lakes' freshwater ice is viewed, when cloud free, by the polar-orbiting satellite's VHRR. A chart (figure 34) is prepared twice weekly and sent to users via the National Facsimile (NAFAX) Network and by mail. The chart reveals the ice-fast and ice-free areas as well as the ice concentration and leads (navigational passageways).

The Alaskan sea ice is viewed, when cloud free, by the polar-orbiting satellite's VHRR. A chart (figure 35) is prepared once a week and sent to users via NAFAX and by mail. The chart reveals the ice-fast and ice-free areas, as well as the ice concentration, age, and leads.

Both analyses are useful to NWS in its forecasting of ice conditions and ship routing.

Accuracy. Human analysis and chart resolution produce an accuracy of ±5 km for both ice charts.

Primary users. The ice charts are used by commercial marine transportation, the U.S. Departments of the Navy and Coast Guard, the National Marine Fishery Service, and varied research concerns.

Figure 34.--Example of Great Lakes ice chart.

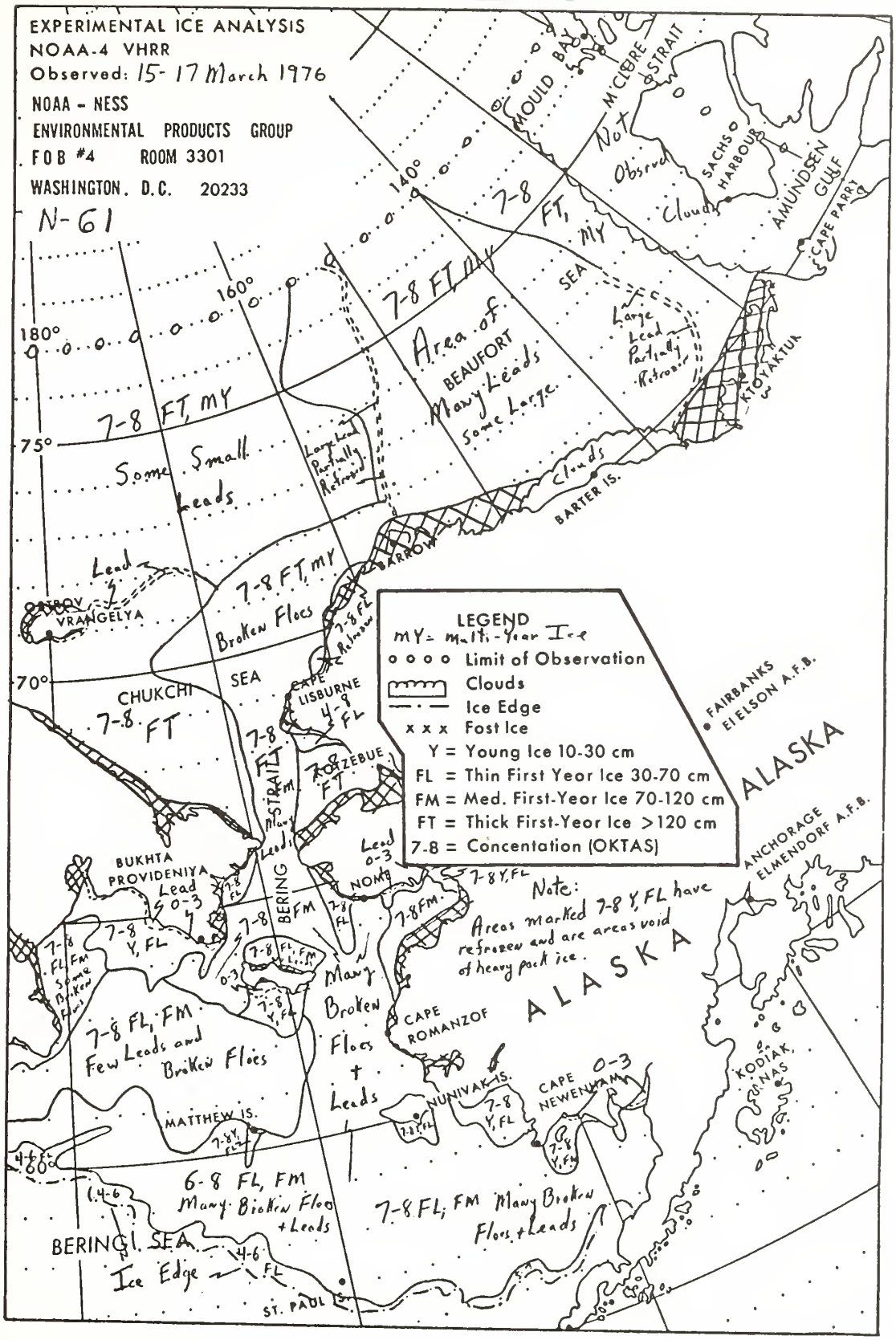

Figure 35.--Example of Alaskan ice chart.

2. Gulf Stream Wall Bulletin and Experimental Gulf Stream Analysis

Description. The Gulf Stream (a warm current flowing northeastward along the east coast of the United States) is of interest to the mariner in the areas of fishing and shipping. The plotting of its position, current speeds, and areas of cold and warm eddies help the mariner in reducing costs in transporting merchandise and locating areas of good fishing.

The Gulf Stream Wall Bulletin (figure 36) informs the mariner of the position of the "North Wall," the zone where the fastest currents are found. This is determined through human analysis of VHRR photographic imagery (Legeckis 1975). Bulletins of the position of the Gulf Stream Wall to 40° N latitude are sent out via teletype three times a week to users.

The Experimental Gulf Stream Analysis (figure 37) is a gridded, 1-km resolution, human analysis of the Gulf Stream prepared from VHRR photographic imagery. This analysis is mailed weekly to users.

Accuracy. Human analysis, chart resolution, and variability of the current produce an accuracy of ±5 km for the bulletin and the analysis.

Primary users. The users of the Gulf Stream data include coastal marine shipping, fisheries, U.S. Coast Guard, recreation and boating interests, and marine research.

May 5, 1976

GULF STREAM LOCATION- THE LINE DESCRIBED BY THE FOLLOWING SEQUENCE OF POINTS REPRESENTS THE WEST WALL OF THE GULF STREAM.

27.3/79.9	28.6/79.8	30.4/80.2
31.7/79.2	31.8/78.1	32.2/77.8
32.8/77.7	32.8/76.8	34.3/75.7
34.5/75.3	36.8/73.2	37.4/71.8
37.4/71.1	37.2/70.8	37.7/69.4

THE MAXIMUM CURRENT OF THE GULF STREAM LIES APPROXIMATELY 15 KM SEAWARD OF THIS LINE.

Figure 36.--Example of Gulf Stream Wall bulletin.

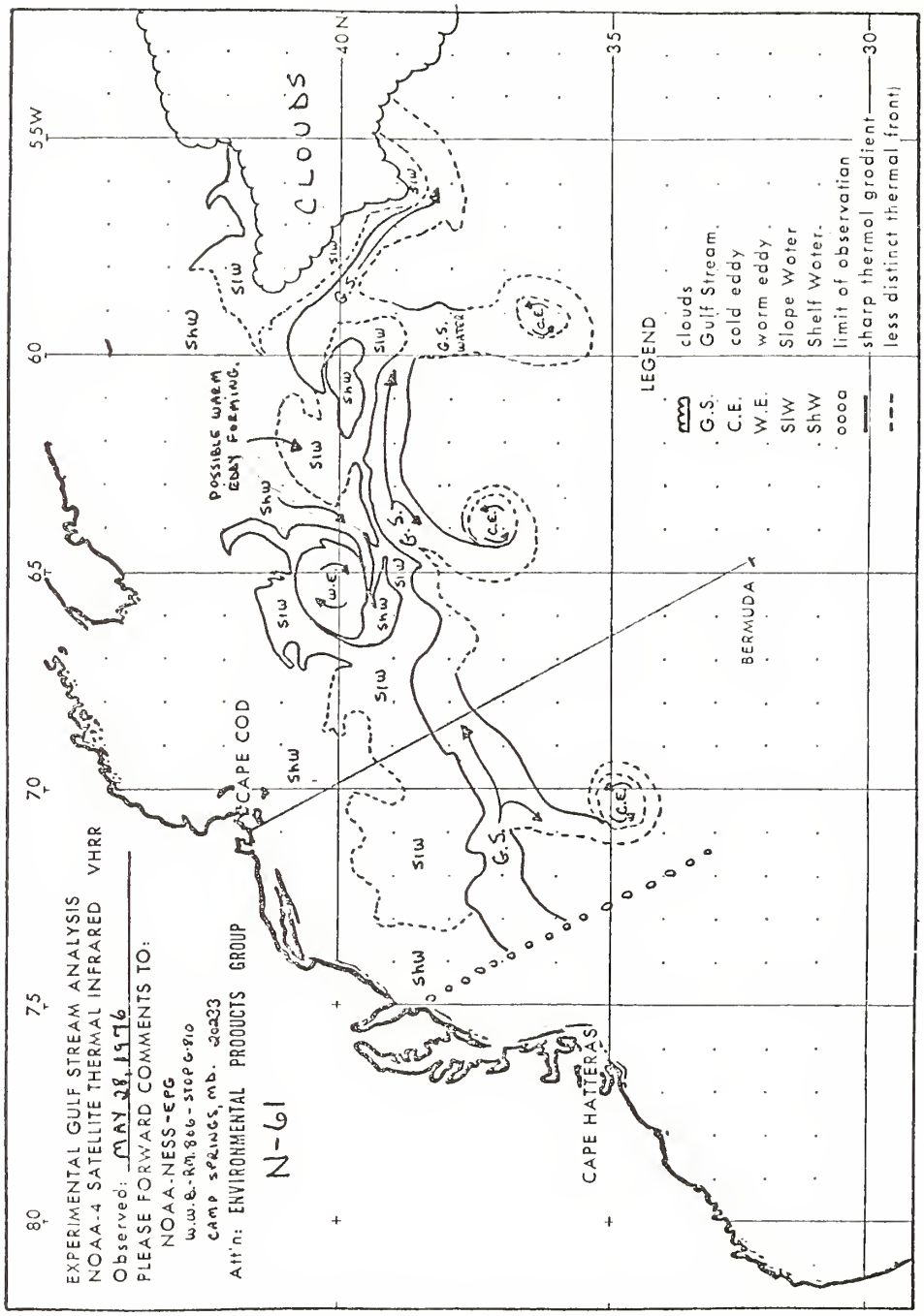

Figure 37.--Example of experimental Gulf Stream analysis.

3. West Coast Thermal Front Analysis

Description. The thermal front analysis of the waters off the west coast of the United States is the main tool used in locating areas of good fishing for California fishermen (Gorman 1976). When upwelling occurs off the coast, the cold waters abound with nutrients. It is along these boundaries, between cold and warm waters, that the fish gather to feed. Analyses of satellite infrared imagery from the VHRR on board the polar-orbiting satellite and the geostationary satellite's Visible Infrared Spin Scan Radiometer (VISSR) are performed, cloud cover permitting, as often as possible. The thermal fronts are drawn on a gridded chart (figure 38) and sent out via telecopier to locations along the California coast. The normal areas covered are from 50° N to 30° N latitude, 4° off the coast of California. Other areas are available upon request. A plastic overlay showing navigation lines and bathometric contours is available on request.

Accuracy. The spatial resolution available to the analysis is 1 km with the VHRR imagery and 8 km with the VISSR imagery. With the reception of VHRR data twice daily and VISSR data every half hour, the analyst is able, cloud cover permitting, to produce an accuracy in location of thermal fronts to ±5 km when the polar-orbiting satellite is directly overhead of the analysis area.

Primary users. Albacore tuna and salmon fishermen.

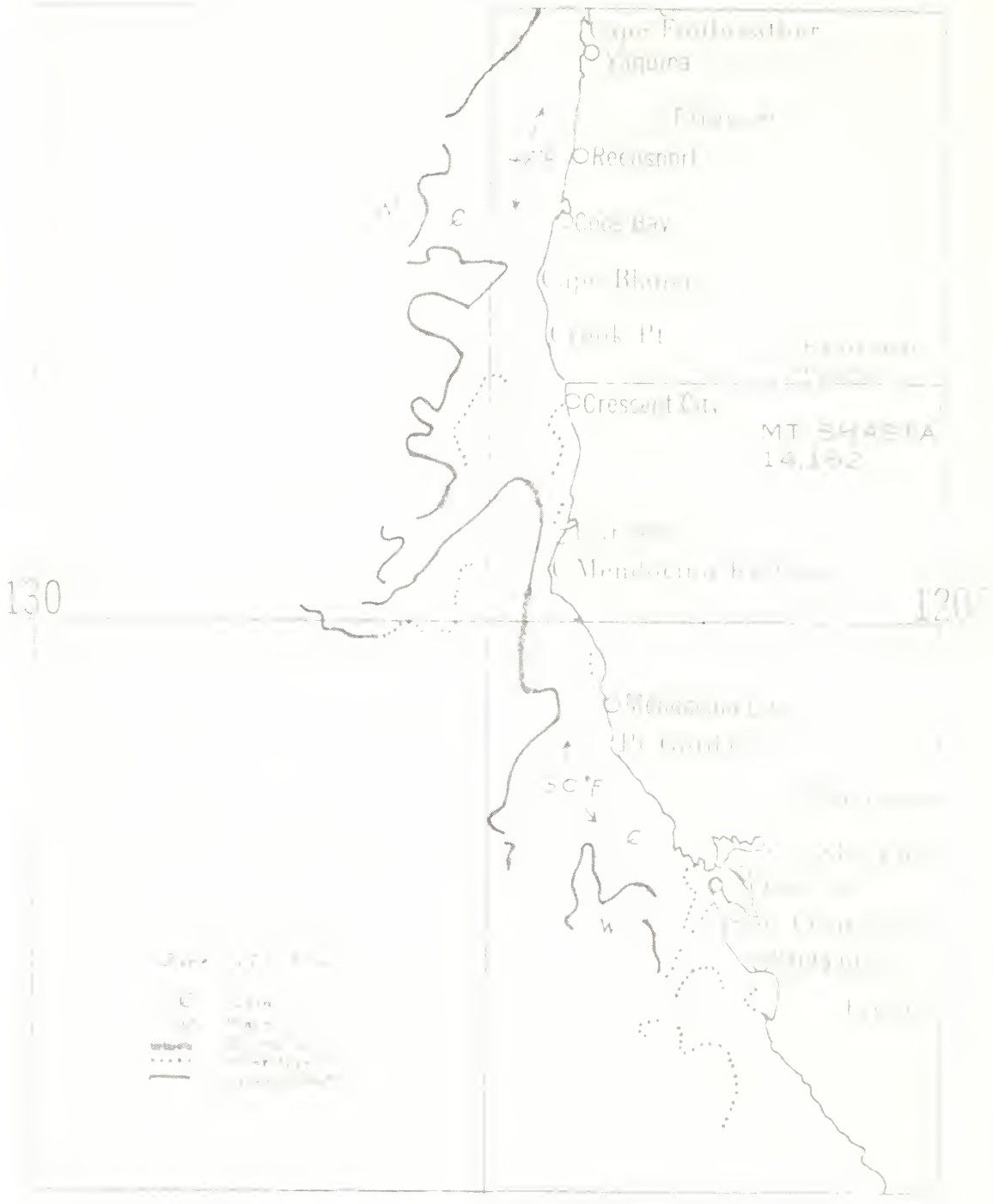

Figure 38.--Example of west coast thermal front analysis.

IV. HYDROLOGICAL SERVICES

A. Basin Snow Coverage Observations

Description. The percentage-snow-cover message sent out via teletype and the mapped snow-covered basin sent out via telecopier are produced for selected river basins by analysis of Very High Resolution Radiometer (VHRR) photographic data. The products are produced whenever a basin is cloud free (usually 1 to 2 days per week). The basin snow-cover products are used in assessing watershed storage and in river forecasting and flood-warning services (Barnes et al. 1974, NESS 1976).

The message (figure 39) indicates the offices that the observations are directed to and a brief description of the percentage of snow cover, the satellite involved, and the date of the observations.

The mapped data show the snow-covered areas in black.

Table 2 lists the basins for operational snow mapping as of June 1, 1976.

Accuracy. The product is accurate to 5% in areas greater than 5,000 km^2 (Wiesnet 1974). The accuracy is checked with aerial surveys, ground measurements, computer (VHRR) enhancements, and, when available, Landsat Multi-Spectral Scanner data.

Primary users. The primary users of snow basin data are the NWS Office of Hydrology, Corps of Engineers, and the Soil Conservation Service.

SPECIAL TO NWS/RFC SALT LAKE CITY, UTAH AND NWS/RDO PHOENIX, ARIZONA

SALT RIVER BASIN 29 PERCENT SNOW COVERED AND VERDE 33 PERCENT AS DETERMINED FROM NOAA-3 SATELLITE IMAGERY OF 3/17/75.

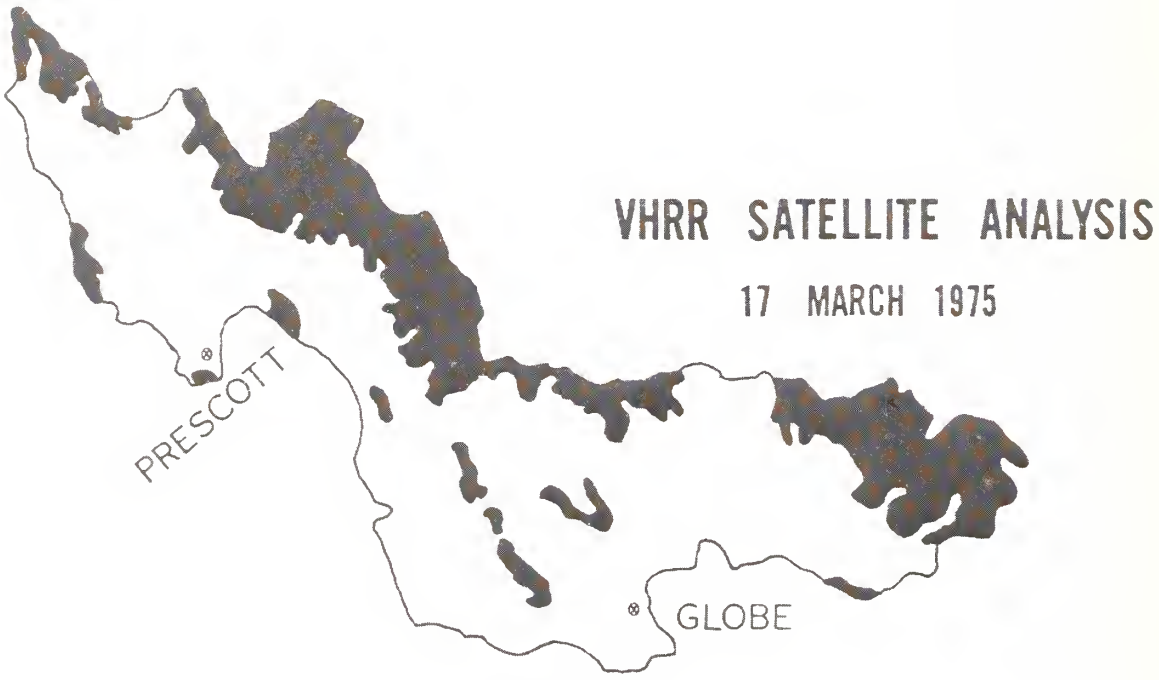

Figure 39.--Example of a percentage snow-cover message and a mapped snow-covered basin for the Salt-Verde Watershed in Arizona. Snow-covered areas are in black (Schneider 1976).

Table 2.--Current basins for operational snow mapping as of June 1, 1976 (Schneider 1976)

River basin	Location	Users
American (above Fair Oaks)	California	Sacramento RFC
Boise (above Lucky Peak)	Idaho	Portland RFC, Columbia Basin Network[1]
Clearwater (above Peck)	Idaho	Portland RFC, Columbia Basin Network
Columbia River (above Mica Dam)	British Columbia	Portland RFC, Columbia Basin Network, B.C. Hydro and Power Authority, Environment Canada
Doschutes	Oregon	Portland RFC, Columbia Basin Network
Humboldt (above Comus)	Nevada	Salt Lake City RFC, Soil Conservation Service
John Day	Oregon	Portland RFC, Columbia Basin Network
Lake of Woods (four subbasins)	Ontario, Canada	Lake of Woods Control Board
North Platte (between Alcova and Guernsey)	Wyoming	Bureau of Reclamation, Kansas City RFC[2]
North Platte (above Seminoe)	Wyoming, Colorado	Bureau of Reclamation, Kansas City RFC
Northeast U.S. Snow Map	New England, New York, Pennsylvania, mid-Atlantic	Regional Hydrologist NWS

[1]The Columbia Basin Network includes the Soil Conservation Service, Bureau of Reclamation, U.S. Geological Survey, U.S. Army Corps of Engineers, National Weather Service, Bonneville Power Administration, B.C. Hydro and Power Authority, as well as other State and local agencies.

Table 2.--Current basins for operational snow mapping as of June 1, 1976 Schneider (1976) (continued)

River basin	Location	Users
Payette (above Emmett)	Idaho	Portland RFC, Columbia Basin Network
Red River of the North (above Emerson, Manitoba)	Dakotas, Minnesota, Canada	Kansas City RFC
Salmon (above Whitebird)	Idaho	Portland RFC, Columbia Basin Network
Salt	Arizona	Salt Lake City RFC, Phoenix RDO, Salt River Project, U.S. Geological Survey
San Juan	Colorado, Utah, Arizona, New Mexico	Salt Lake City RFC
Souris River (above Westhope, N.D.)	North Dakota, Canada	Kansas City RFC, Environment Canada
St. John	Maine, New Brunswick	Maine Bureau of Civil Emergency Preparedness, New Brunswick Dept. of Environment, Environment Canada, St. John Basin Task Force[3]
Sweetwater (above Pathfinder)	Wyoming	Bureau of Reclamation, Kansas City RFC
Umatilla	Oregon	Portland RFC, Columbia Basin Network

[2]Basins being done for the Bureau of Reclamation in Denver, Colo., are retransmitted from that site to field offices in Casper, Laramie, and Cheyenne, Wyo.

[3]The St. John Basin Task Force includes the National Weather Service, U.S. Army Corps of Engineers, U.S. Geological Survey, Environment Canada, and other State and local agencies.

Table 2.--Current basins for operational snow mapping as of June 1, 1976 Schneider 1976) (continued)

River basin	Location	Users
Verde	Arizona	Salt Lake City RFC, Phoenix RDO, Salt River Project, U.S. Geological Survey
Weiser	Idaho	Portland RFC, Columbia Basin Network
Willamette	Oregon	Portland RFC, Columbia Basin Network

B. Northern Hemispheric Snow and Ice Chart

Description. The product is a polar-stereographic projection map of snowfield and icefield boundaries and their relative reflectivities for the Northern Hemisphere. The 8.5-by-11-in chart (figure 40) with a scale of 1:50M is prepared weekly and mailed to users on Mondays. The charts are manually prepared using the data from the polar-orbiting satellite's Scanning Radiometer (SR) and VHRR and the geostationary satellite's Visible Infrared Spin Scan Radiometer (VISSR). The product is used in the areas of snow- and ice-limit tracking, albedo studies, long-range weather forecasting, and various research projects.

Accuracy. The chart is a 1-week composite average of snow and ice conditions. Snow- and ice-boundary mapping is hindered by cloud cover, and the determination of snow reflectivities is hindered by the terrain being covered. The data used are in the visible window, so the chart gives snow brightness but not snow depth. For this same reason, the snow and ice chart is labeled "dark" (no observations available) in the polar zones under the darkness of winter.

Primary users. The product is used by the U.S. Navy, various foreign and domestic universities, Government agencies, meteorological services, and research groups.

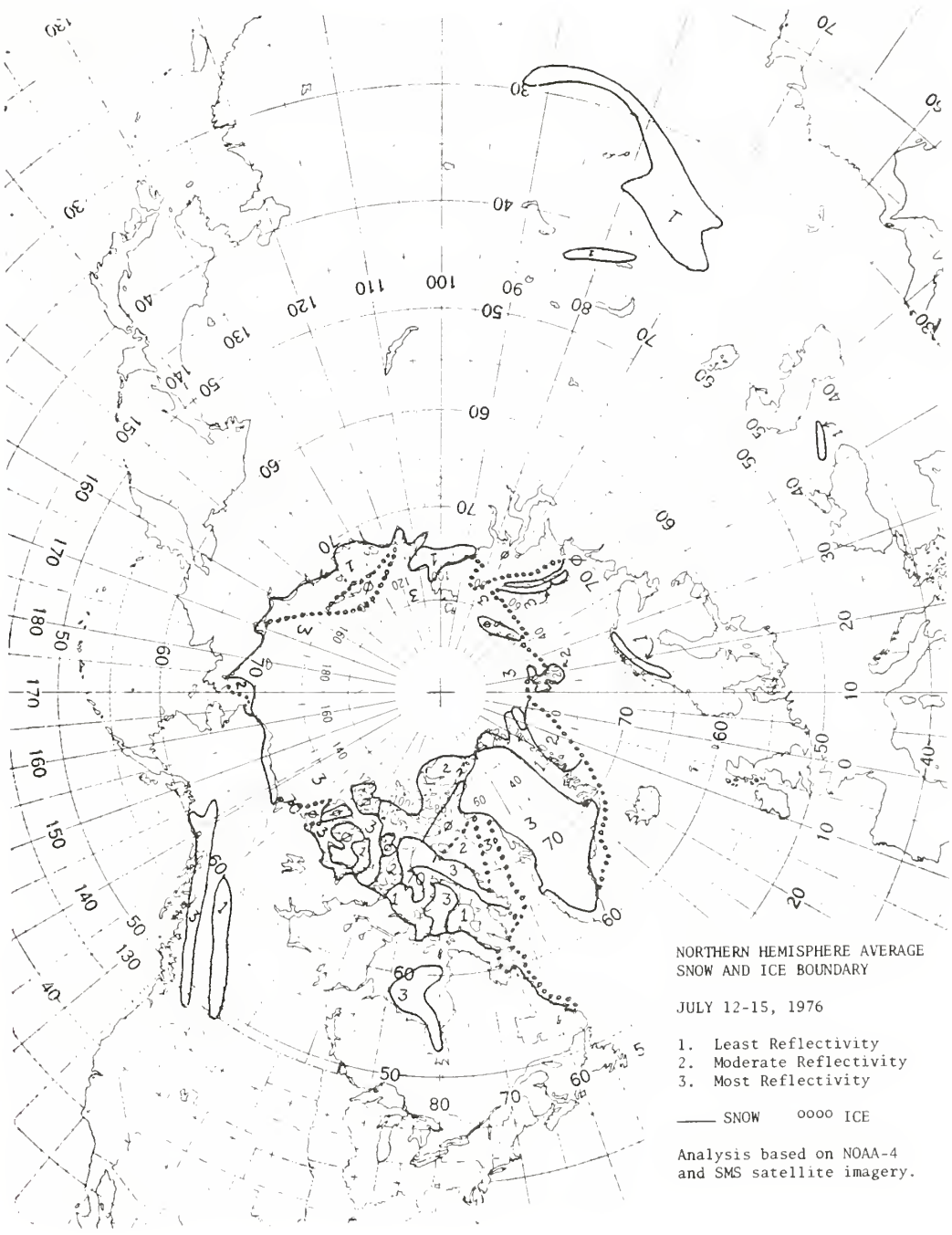

Figure 40.--Example of Northern Hemisphere snow and ice chart.

V. ASTROGEOPHYSICAL SERVICES: ASTROGEOPHYSICAL TELETYPE NETWORK (ATN) MESSAGES

Description. The Solar Proton Monitor (SPM) is used in the preparation of warnings of solar proton storms and in the measurement and prediction of solar flare activity. The SPM measures the flux of energetic particles (protons, electrons, and alpha particles) in 20 energy ranges. Protons are measured in the 10-, 30-, 60-, and 0.27- to 60-MeV ranges; electrons in the 100- and 750-KeV ranges; and alpha particles in the 12.5- to 32.0 MeV range. One set of detectors measures the flux towards the earth along the local vertical. A second set of detectors measures the flux along the orbital normal to the side of the spacecraft away from the sun.

The data are tape recorded in digital form on board the spacecraft. These data are transmitted to the Command and Data Acquisition (CDA) station and are immediately processed by the National Environmental Satellite Service (NESS) (Brown 1975). A quick-look, 4.16 line per min. message (figure 41) is generated and transmitted on the ATN. Global data are merged monthly into a tape that is mailed to users.

All SPM archival data are sent to

Space Environmental Laboratory
National Oceanic and Atmospheric Administration (NOAA)
Boulder, Colo. 80302

The data are archived by orbit, in their entirety, on magnetic tape.

Accuracy. The instrument's output from all operational satellites is within expected accuracy tolerances of ±5%.

Primary users. Space Environmental Laboratory.

Header line for the recorded data teletype message:

```
1   2   3    4        5      6   7  8  9  10 11 12   13
QL/SPM/NH/Rxxxxx/ELxxx.xx/Pxxxxx/MO/DA/YR/HR/MN/SC/bbbb.......b
```

Sample teletypewriter messages:

```
HSAK KSOC 022305
QL/SPM/SH/R00993/EL343.27/P00992/01/02/73/23/06/07.0/
0000-077120120005-027124132137-133132140346-275142154431-334142144427
0410-255132132330-150131106175-067125124006-006124124002-010123121003
0320-006124124001-007123122001-007124120003-010124120001-006123122003
1236-037124121008-006123113002-007135122004-006123122092-007123194001
1640-007126124002-010122121004-004123123002-013122124022-230112412627
2050-327164141426-373163127323-357221157531-263223242522-145150246424
2666-061184257272-142142827022-233220422235-321250455272-350276467320
2910-426322461322-453334455331-99999

HSAK KSOC 022221
QL/SPM/NH/R00993/EL343.27/P00992/01/02/73/22/57.0/
0000-006130126001-006131126003-010126127001-006127127003-011126125001
0410-006130125002-010130125002-007125124002-007126126002-042126125052
0320-223130131247-321133141375-351153144456-325157156455-164141170421
1230-034126144227-123124065121-171122235065-226133244067-254126244045
1640-99999
```

Item	Description
1,2.....	Basic identification, QL/SPM (Quick Look/Solar Proton Monitor)
3	Sector, NH (Northern Hemisphere), SH (Southern Hemisphere
4	R (readout identifier followed by 5-digit readout number**)
5	EL (degrees east, 0-359.99, ascending longitude of pass)
6	P (pass identifier followed by 5-digit pass number**)
7	Month, 2 digits, GMT of data start
8	Day, 2 digits, GMT of data start
9	Year, 2 digits, GMT of data start
10	Hour, 2 digits, GMT of data start
11	Minute, 2 digits, GMT of data start
12	Second, 2 digits, GMT of data start
13	b (blanks)

**The readout number refers to the orbital revolution in which the data were acquired at the ground. The pass number refers to the orbital revolution in which the data were taken.

Figure 41.--Example of an Astrogeophysical Teletype Network (ATN) Message.

Table 3.--Product summary

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule[2]	User	Archive location
Full-disk (VIS and 1R): East GOES	--	4 km VIS 8 km 1R	--	Pole to Pole, 65 W to 165 E	Photographic display and archive tape[1]	At hour and half hour	NWS, NMC, NESS and Government, universities, and private research	SDSB
West GOES				Pole to Pole, 15 W to 145 E		At 15 and 45 mins after hour		
Sectors (VIS and 1R):								
DA--1,2,6,7	--	1 km	--	Specific areas; see text	Do.	E-P,E-P,W-R,W-R	Do.	Do.
DB--5,10		2 km				E-P,W-R		
KA--3,3R,4,4R,5,5R		1 km				E-P,W-R,E-P,W-R		
KB--3,4,8,9		2 km				E-P,W-R W-R,E-P,E-P,W-R		
SA--1,2,6,7		1 km				W-P,W-P,E-R,E-R		
SB--1,6		2 km				E-R,W-P		
UC--1,2		4 km				E-R,W-P		
WB--1		2 km				E-P		
WC--1,2		4 km				E-P&R,W-P&R		
Direct readout and GOES-Tap VISSR data	--	Same as full-disk and sector displays	--	Same as full-disk and sector displays	Photographic imagery	Same as full-disk and sector displays	Foreign and domestic governments, universities, commercial organizations, research concerns, amateur ground station operations, GOES-Tap, private meteorology	No archive
Movie loops (VIS/1R/1R-enhanced)	--	1, 2, 4, 8 km	--	Do.	80 or more joined in stop, flow, or alternated stop loop	In-house/daily, others on request (see text for list)	NESS--Applications Group and Wind Section	Applications Group
TV filmstrips	--	2 km	--	Continental United States	Commercial TV film	Daily	Commercial TV	SDSB
U.S. cloud cover	--	Do.	--	Do.	Photographic display, surface analysis chart and weather summary	Do.	NOAA hdqtrs, NESS, ERL's, NASA, DOC, news media	Do.

Table 3.--Product summary (continued)

Product description	Accuracy	Spatial resolution	Map scale	Geographic coverage	Output format	Schedule	User	Archive location
SMS/GOES facsimile displays (VIS and IR)	--	VIS: 4x4 km IR: 4x8 km	Polar:1:20M Mercator: 1:20M	Continental United States--~55-120 W long. and 15-60 N lat.; Eastern United States and Atlantic--~20-90 N long. and 15-60 N lat.; Southern South America--~25-80 W long. and 10-50 S lat.; U.S. West Coast and Pacific--~115-180 N long. and 15-60 N lat.; Western United States and Pacific--~105-180 W long. and 15-60 N lat.	Facsimile display	24-h schedule (see latest NWS FAX list)	NWS, DOD, NESS, private meteorology, universities, research concerns	No archive
SMS/GOES WEFAX link: SMS/GOES and NOAA polar-orbiter data in VIS and IR	--	Same as photographic imagery	1:80M	Specified areas (see latest NESS WEFAX list)	Facsimile--satellite-relayed broadcast	24-h schedule (see latest NESS WEFAX list)	Foreign and domestic weather concerns with APT S-band receiving equipment	Do.
ATS WEFAX link: NOAA polar-orbiter data in VIS and IR	--	Do.	Do.	Selected mapped mosaics (see latest NESS WEFAX list)	Do.	Do.	Do.	Do.
Gridded unrectified pass-by-pass SR VIS images	--	6.5 km	1:35M (unmapped)	Selected passes	Gridded unmapped photographic displays	Daily, selected passes	NWS, DOD, NESS	SDSB
SR hemispheric polar-stereographic mosaics (VIS and IR)	--	1:30M	1:480M	Northern and Southern Hemispheres	Mapped photographic displays and archive tape	Daily	NESS, ERL's, DOD	Do.
SR polar-stereographic quadrant mosaics (VIS and IR)	--	Do.	1:40M	Do.	Mapped photographic displays	Do.	NESS, NWS, DOD	No archive
SR Mercator mosaics (VIS and IR)	--	10 km at equator increasing to 8 km at 40 N. or S.	1:180M	Northern and Southern Hemispheres to 40 N or S	Do.	Do.	NESS, NWS, ERL's, DOD	SDSB

Table 3.--Product summary (continued)

Product description	Accuracy	Spatial resolution	Map scale	Geographic coverage	Output format	Schedule	User	Archive location
Very High Resolution Radiometer basic images (VIS and IR)	--	1 km	--	Selected passes	Photographic displays and archive tape[3]	Daily, selected passes	NESS, NWS, ERL's, NMFS, NASA, DOD, Arctic Inst., universities, and foreign, research, weather agencies	SDSB
Ten-day minimum Composite Brightness (VIS and IR)	--	1:75M	1:120M	Northern and Southern polar regions to 50 N or S	Do.	Daily	NESS--ESG, OPMS, SAS	SDSB
Polar-orbiting satellite facsimile displays (VIS and IR)	--	1:120M--Mercator 1:30M--polar-stereographic	1:20M	Specified areas	Facsimile display	Daily, selected passes	NWS, DOD, NESS, private meteorology, universities, research concerns	None
Polar-orbiting satellite--direct readout: SR, VHRR, VTPR, SPM	--	Same as SR and VHRR products listed above	--	Selected areas	Photographic imagery and alphanumeric data	Do.	Foreign and domestic government agencies, universities, commercial organizations, research concerns, amateur ground station operators	SDSB
Satellite winds: low-, middle-, high-level cloud motion vector field messages	See text	--	--	Global ocean areas	Raw numeric data, chart form and archive	00Z and 12Z, daily for distribution at 03Z and 15Z	NMC, various research concerns	None
					Cloud motion vectors--archive tape			SDSB
Atmospheric soundings:								
Atmospheric temperature at 15 standard levels	2-3° C	500 km	--	Global ocean areas	Teletype code NMC format and archive tape	Orbit by orbit as received from CDA stations	NMC, global weather centers, DOD	SDSB
Atmospheric thickness relative to 1,000 mb (0 height) at 14 standard levels beginning at 850 mb	0.25 mW/m^2 sr cm^{-1}							

Table 3.--Product summary (continued)

Product description	Accuracy	Spatial resolution	Map scale	Geographic coverage	Output format	Schedule	User	Archive location
Atmospheric soundings: (cont'd) Polar-stereographic maps of raw VTPR radiances for moisture, jet stream, high clouds, and stereo; warming determination		Full (57 km)	--	Global	Polar-stereographic computer-mapped radiance values and polar-stereo mapped photographs and archive tape	Twice daily	NMC--UAB and NESS--SAS	SDSB (tape only)
Satellite Interpretation Message (SIM)	±6 n.mi. (8.4 km)	--	--	Continental United States	Teletype	Washington, D.C., SFSS: 8/day Kansas City SFSS: 8/day Miami SFSS: 1/day (in-house) Honolulu SFSS: 2/day Anchorage SFSS: 2/day	Domestic weather operations	No archive
Satellite Weather Bulletins	--	--	--	Atlantic, Pacific, Indian Oceans	Do.	As needed	Foreign and domestic weather operations	No archive
Tropical Disturbance Summary	±30 n.mi. (42 km)	--	--	Atlantic and East Pacific (to 180 W), West and South Pacific, Indian Ocean	Do.	2/day/area	Do.	No archive
Two-layer moisture analysis	±30%	--	1:20M	Eastern North Pacific Ocean, Western North Atlantic Ocean, Gulf of Mexico	Gridded analysis	Daily, 00Z and 12Z	Basic Weather Branch and Quantitative Precipitation Branch, NMC	No archive
Satellite Input to Numerical Analysis and Prediction (SINAP)	--	--	Do	North Atlantic	Do.	Do.	Aviation Weather Branch, NMC	Do.
Global operational sea surface temperature observations	±1.5° C absolute; ±0.5° C relative	100-km gridded analysis	1:480M--photographic display	Global	Computer-derived photographic display, gridded analysis, archive tape	1/day	NWS, Oceanographic Services, environmental research, commercial fisheries	SDSB

Table 3.--Product summary (continued)

Product description	Accuracy	Spatial resolution	Map scale	Geographic coverage	Output format	Schedule	User	Archive location
Great Lakes surface temperature analysis	±1.5° C absolute; ±0.5° C relative	1 km	Varies with type of transmission	Great Lakes	Gridded analysis	When observable (usually 1/ week)	NWS, Great Lakes Research Lab, commercial fisheries	No archive
Great Lakes and Alaskan ice charts	±5 km	Do.	Do.	Charts: Great Lakes; N. Atlantic Ocean, Bering Sea and Strait, Chukchi Sea, Beaufort Sea	Do.	Do.	Commercial Marine Transportation, USN, USCG, NMFS, research concerns	Do.
Gulf Stream Wall bulletins and experimental Gulf Stream analysis	Do.	Do.	Do.	Gulf Stream out to 40 N lat., 60 W long.	Teletype message Gridded analysis	M,W,F 1/week on Wed.	Coastal marine transportation, fisheries, USCG, recreation and research concerns	Do.
West coast thermal front analysis	Do.	Do.	Do.	50 N to 30 N lat. 4° off California coast; others on request	Gridded analysis	When observable (2/week or more)	Albacore tuna and salmon fisheries	Do.
Basin snow coverage observations	±5%	Do.	Do.	Selected basins (see text)	Percentage-covered analysis	When observable (usually 1/week)	NWS OH, Corps of Engineers, Soil Conservation Service	Do.
Northern Hemisphere snow and ice chart	±5 km	1 km	1:50M	Northern Hemisphere	Gridded analysis	Weekly	USN, other marine interests	SDSB
Astrogeophysical Teletype Network (ATN) message	±5%	--	--	Global	Teletype Archive tape	13/day Monthly	Space Environmental Lab	Space Environmental Lab

[1] 8 km VIS and IR (five IR and one VIS pictures daily per tape for each satellite). See text.

[2] E = East-GOES schedule, hourly and at half hour; W = West-GOES schedule, at 15 and 45 minutes after the hour; P = primary sector; R = reserve sector (used in the event of E- or W-GOES failure).

[3] 90-day rotating digital tape starting January 1, 1977.

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